Wrocław University of Science and Technology

ISEP

BRNO FACULTY UNIVERSITY OF CHEMISTRY OF TECHNOLOGY

Universidade Vigo

GDAŃSK UNIVERSITY OF TECHNOLOGY

TECHNOLOGIES TOWARDS CIRCULAR ECONOMY AND ENVIRONMENTAL SUSTAINABILITY

BLENDED INTENSIVE PROGRAMME (BIP)

Online: 10th to 21st March 2025

At Porto : 7th to 12th April 2025

Blended Intensive Programme

General information

- Blended Intensive Programmes (BIPs) are an innovative form of learning, teaching, and training aimed at providing an intensive learning experience that combines physical and virtual components. These programs are developed and implemented by a minimum of three Higher Education Institutions (HEIs) from at least three Member States of the European Union and countries associated with the program, and they are funded through the Erasmus+ mobility program.

- BIPs are short, intensive programs that promote challenge-based and inquiry-based learning. They combine online cooperation with short-term physical mobility abroad (typically lasting one week), allowing participation in teaching and training activities with experts from all partner institutions.

- The combined online cooperation and physical mobility must award students a minimum of three ECTS credits (84 hours)

Multidisciplinary programme

- Chemical Engineering
- Bioresources Engineering
- Environmental Engineering
- Industrial Engineering

Objectives

Designing processes to convert raw materials into valuable products sustainably, while minimizing environmental impact; green engineering & green chemistry; carbon capture technologies; sustainable and biodegradable materials; recycling technologies.

Holistic approaches to designing and managing complex biosystems with sustainability and circularity in mind; optimizing resource flows, integrating circular principles in product and process design, and managing sustainability in supply chains.

Optimizing production processes and systems for efficiency, productivity, and sustainability, circular supply chains, and life-cycle assessment of products and processes.

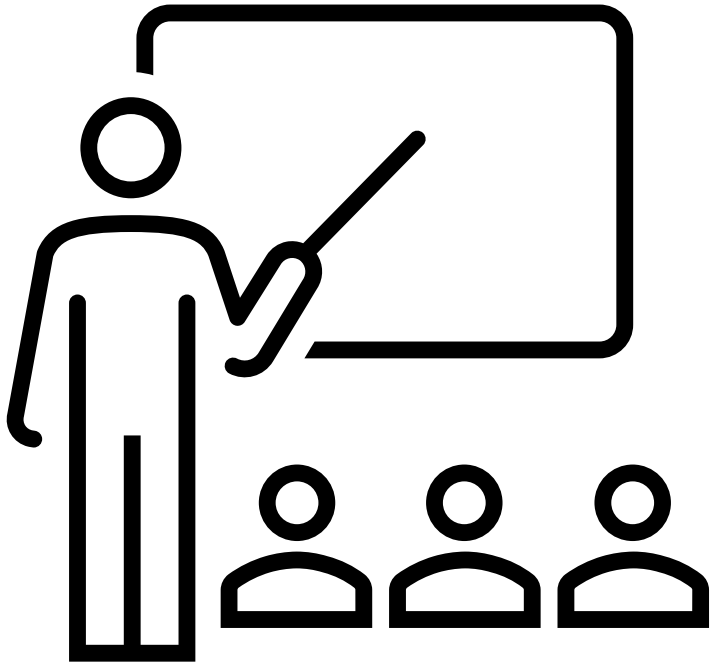
Environmental protection, pollution control, waste management, and sustainable resource use and circularity.

Online Program (10th to 21st March 2025)

	Schedule	Activity	
Monday 10th March 2025	15:00-15:30 15:30-17:45	BIP presentation session Lecture #01-Recovery of materials and energy from food waste Lecture #02-Turning waste into resources: Processing of wheat bran in a circular economy framework Lecture #03--Potential Use of Agroforestry Residues as Adsorbent for Environmental Applications	ISEP Team Anna Witek-Krowiak Pavel Diviš, Jaromír Pořízka Emilio Rosales Villanueva
Thursday 13th March 2025	15:30-17:45	Lecture #04--Life cycle analysis Lecture #05-Mercury: challenges for the water environment Lecture #06-Transforming Food Waste through Fermentation	Florinda Martins Piotr Konieczka Jannes Van Houcke
Monday 17th March 2025	15:00-16:00 16:00-17:00	Presentation of project topics Group formation and selection of projects	All Project supervisors and students
Friday 21th March 2025	15:00-17:00h (or other convenient schedule)	Individual Hands-On Project group meetings between students and supervisors	All Project supervisors and students

Face to face activities (7th to 12th April 2025)

	Schedule	Activity	
Monday 7th April 2025	9:30-10:30h 10:30-11:30h 11:30-12:30h	Opening /Welcome session Lecture #P1-Valorization of waste biomass through advanced recovery methods Lecture #P2-Production of bioplastics and composites from chestnut industry waste	All partners Anna Witek-Krowiak Valentina Domingues
	12:30-14:00h	Lunch	
	14:00-16:00h 16:00-18:00h	Hands-on project activities: Supervised group work development Social Program	All Project supervisors ISEP Team
Tuesday 8th April 2025	9:30-11:00h 11:00-12:30h	Lecture #P3-Advances in the Eco-design and Synthesis of Materials for Environmental Applications Lecture #P4-Trends in Fenton-based Processes for wastewater and soil remediation	Mª Angeles Sanronán Braga Marta Pazos Curras
	12:30-14:00h	Lunch	
	14:00-16:00h 16:00-18:00h	Hands-on project activities: Supervised group work development Social Program	All Project supervisors ISEP Team
Wednesday 9th April 2025	9:30-11:00h 11:00-12:30h	Lecture #P5-Nutrient recycling in Wastewater Treatment Plants Lecture #P6-Reusing Treated Wastewater for Irrigation	Manuela Correia Sónia Figueiredo
	12:30-14:00h	Lunch	
	14:00-18:00h	Visit to local industries	ISEP Team
Thursday 10th April 2025	9:30-11:00h 11:00-12:30h	Lecture #P7-Mercury in Your Environment: Steps You Can Take Lecture #P8- To be confirmed	Małgorzata Rutkowska
	12:30-14:00h	Lunch	
	14:00-18:00h	Hands-on project activities: Supervised group work development	All Project supervisors
Friday 11th April 2025	9:30-12:30h	Hands-on projects: presentation and overall discussion	All participants
	12:30-14:00h	Lunch	
	14:00-18:00h	Hands-on projects: presentation and overall discussion	All participants
Saturday 11th April 2025	9:30-12:30h	Closing session	All participants



Lectures

Lecture #01- Recovery of materials and energy from food waste

Anna Witek-Krowiak, anna.witek@pwr.edu.pl

Syllabus

This lecture delves into the potential of food waste as a renewable resource for recovering valuable materials and energy. Key topics include (bio)chemical and thermochemical conversion processes, such as hydrolysis, anaerobic digestion, pyrolysis, and gasification, for producing bioenergy and bio-based materials. Students will explore the principles of circular economy and sustainability in waste management.

Outcomes

1. *Understand the principles of (bio)chemical and thermochemical processes for recovering energy and materials from food waste.*
2. *Identify various types of biomass waste and their potential applications in producing biofuels, biogas, and bio-based materials.*
3. *Evaluate the role of waste biomass recovery in promoting circular economy and sustainability.*

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Lecture #02- Turning waste into resources: Processing of wheat bran in a circular economy framework

Pavel Diviš, divis@fch.vut.cz

Jaromír Pořízka, porizka@fch.vut.cz

Syllabus

Wheat bran: composition and potential

The circular economy framework

Biorefinery concept

Wheat bran processing technology

Applications of processed wheat bran

Outcomes

Understanding the potential of wheat bran

Knowledge of processing techniques

Integration of circular economy principles

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Lecture #03- Potential Use of Agroforestry Residues as Adsorbent for Environmental Applications

Emilio Rosales Villanueva, emiliorv@uvigo.gal

Syllabus

This presentation explores the potential use of agroforestry residues as cost-effective and sustainable adsorbents for environmental applications, particularly in wastewater treatment. Key topics include the types of agroforestry residues, their adsorptive properties, and the mechanisms behind pollutant removal. Additionally, the environmental and economic benefits of using these materials compared to traditional adsorbents will be highlighted.

Outcomes

- *Understand the characteristics and benefits of agroforestry residues as adsorbents.*
- *Identify potential environmental applications for agroforestry residues in pollution control.*
- *Assess the advantages and challenges of using agroforestry residues over conventional adsorbents.*
- *Gain insights into ongoing research and future directions for agroforestry-based adsorption technologies.*

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Lecture #04- Life Cycle Analysis

Florinda F. Martins, ffm@isep.ipp.pt

Syllabus

Life cycle of products and services is very important and meaningful since it can help to reduce economic, environmental and social impacts, being crucial to achieve sustainability. It is a key tool for determine hot spots and effectively find out improvement opportunities. Life cycle assessment it is a methodology to determine environmental impacts that considers the life cycle of the product. If the goal is to determine economic impacts, Life Cycle Costing can be applied.

Outcomes

- *To understand key concepts of Life Cycle Analysis*
- *Know how to apply the methodology LCA*
- *To understand key concepts of LCC and know how to apply the methodology LCC*

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Lecture #05- Mercury: challenges for the water environment

Piotr Konieczka, piokone@pg.edu.pl

Syllabus

1. Issues associated with mercury contamination in aquatic ecosystems.
2. The pervasive nature of mercury as a pollutant, emphasizing its presence in water samples and its significant implications for environmental health.
3. Ecological disasters linked to mercury, serving as stark examples of its toxic effects on both ecosystems and human populations.
4. The critical need for robust monitoring and accurate determination of mercury levels in environmental samples, particularly water.
5. State-of-the-art analytical techniques for mercury quantification which enable precise and reliable detection.
6. Potential strategies for the management and reclamation of mercury.

Outcomes

1. *Understanding Mercury's Environmental Impact*
   Participants will gain insight into the sources, behavior, and toxicological effects of mercury, particularly in aquatic ecosystems, highlighting its role as a persistent and hazardous pollutant.

2. *Awareness of Ecological Disasters*
   The lecture will provide a critical analysis of major ecological incidents caused by mercury contamination, fostering an understanding of the profound environmental and societal consequences of inadequate mercury management.

3. *Proficiency in Mercury Monitoring Techniques*
   Attendees will become familiar with advanced methodologies for the detection and quantification of mercury in water and other environmental samples, including key instrumental techniques such as CVAAS and ICP-MS.

4. *Exploration of Sustainable Mercury Management*
   The lecture will give example of the innovative approaches for mercury reclamation and disposal from waste streams, offering practical solutions to mitigate its environmental footprint while advancing sustainability goals.

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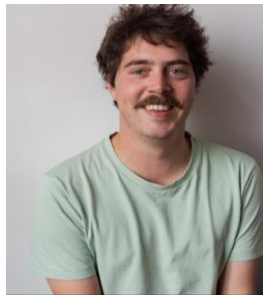
Lecture #06- Transforming Food Waste through Fermentation



Jannes Van Houcke, jannes.vanhoucke@odisee.be

Syllabus

This presentation explores the transformative role of fermentation in the circular economy. Key topics include the main types of fermentation—such as aerobic, anaerobic, and precision fermentation—and their mechanisms. Different fermentation processes will be discussed, focusing on the use of microorganisms to convert food waste into high-value products, including alternative proteins and sustainable ingredients, illustrated exclusively through real-world case studies.

Outcomes

1. Understand the key types of fermentation (aerobic, anaerobic, and precision fermentation) and their mechanisms in converting food waste into valuable products.
2. Recognize the role of microorganisms in creating sustainable ingredients and alternative proteins from food waste streams.
3. Learn from real-world case studies how fermentation technologies are applied in the circular economy, particularly within the food industry.
4. Explore opportunities to implement fermentation-based innovations in their own industries or sustainability initiatives.

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Lecture #P1- Valorization of waste biomass through advanced recovery methods

Anna Witek-Krowiak, anna.witek@pwr.edu.pl

Syllabus

This lecture explores innovative approaches for the utilization of waste biomass, focusing on the recovery of valuable components through hydrolysis and extraction methods. Participants will gain insights into the chemical and enzymatic processes involved in converting biological waste into high-value products. Key topics include the selection of feedstocks, optimization of recovery techniques, and applications of extracted bioactive compounds in various industries. The lecture will also address environmental and economic benefits of biomass valorization, emphasizing sustainability and waste minimization. Case studies and practical examples will illustrate the potential of these methods in promoting a circular bioeconomy.

Outcomes

1.Understand the principles and mechanisms of hydrolysis and extraction methods for biomass valorization.

2. Identify key feedstocks and their potential for recovering valuable bioactive compounds.

3.Analyze the environmental and economic benefits of waste biomass utilization.

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Lecture #P2- Production of bioplastics and composites from chestnut industry waste

Valentina Domingues, vfd@isep.ipp.pt

Syllabus

The presentation explores methods for utilizing chestnut byproducts, such as shells, husks, and chestnut with no commercial value to create sustainable bioplastics and composite materials. It covers the process of converting waste into valuable resources through extraction (according to green chemistry) and processing techniques. The lecture also discusses the environmental benefits, challenges, and potential applications of these bioplastics and composites.

Outcomes

- *Understand the innovative methods that use chestnut byproducts, such as shells and husks, into bioplastics.*
- *Understand the process of turning chestnuts with no commercial value into biocomposites, contributing to a circular economy and reducing environmental impact.*
- *Identify the key environmental benefits and challenges associated with utilizing chestnut industry waste in the production of bioplastics and composites.*
- *Evaluate the potential applications of chestnut-based bioplastics and composites in various industries.*

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Lecture #P3- Advances in the Eco-design and Synthesis of Materials for Environmental Applications

M ª Angeles Sanromán Braga, sanroman@uvigo.gal

Syllabus

This presentation covers recent advances in green materials and synthesis methods for environmental applications, with a focus on biochar, hydrochar and carbon nanostructured materials for environmental applications. It will cover their production processes and role as sustainable materials for application in several environmental treatments. The presentation will highlight how these green materials, produced from biomass waste, align with principles of green chemistry and contribute to environmental sustainability.

Outcomes

Understand the principles of green synthesis

Production of biochar, hydrochar and carbon nanostructured materials from biomass.

Identify the environmental applications of these materials in several advanced treatments.

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Lecture #P4- Trends in Fenton-based Processes for wastewater and soil remediation

Marta Pazos Curras, mcurras@uvigo.gal

Syllabus

This presentation explores the role of Fenton-based processes in wastewater and soil remediation, with an emphasis on recent trends and their contribution to environmental sustainability. It will cover the fundamental principles of the Fenton reaction, modifications to enhance its efficiency, and its application in environmentally-friendly practices. The presentation will highlight the process's potential for reducing environmental pollutants while contributing to sustainable resource management and minimizing chemical waste.

Outcomes

- *Understand the principles and mechanisms of Fenton-based processes in the context of environmental sustainability.*
- *Identify how advancements in Fenton-based techniques contribute to greener, more efficient wastewater and soil remediation.*
- *Gain insights into the integration of Fenton-based remediation in sustainable environmental management strategies.*

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Lecture #P5- Nutrient recycling in wastewater treatment plants

Manuela Correia, mmb@isep.ipp.pt

Syllabus

The new text of the Urban Wastewater Treatment Directive (UWWTD) revises a 33-year-old UWWTD, introducing new challenges in terms of water treatment, energy management and circular economy. As an example, particular attention is given to sludge valorisation and nutrient recovery (nitrogen, N, and particularly phosphorus, P), establishing the need, in some cases, of tertiary treatment for N and/or P removal. Nutrient recycling is a promising strategy for reducing the depletion of non-renewable resources and the environmental impact linked to their extraction and production.

Outcomes

Understand the basic principles of wastewater treatment and nutrient removal

Integration of Circular Economy principles in WWTPs: from removal to recycling

Knowledge of different technologies for nutrient recovery

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Lecture #P6- Reusing Treated Wastewater for Irrigation

Sónia Figueiredo, saf@isep.ipp.pt

Syllabus

- *Water in Europe*

- resources, uses, scarcity

- *Reuse of treated wastewater for irrigation*

- Water reuse regulation

- Quality parameters

- New urban wastewater treatment directive

- *The challenge of micropollutants: pharmaceutical compounds and microplastics*

- Analytical methods

- Research for sustainable and effective treatments

Outcomes

- *To acquire knowledge about the circular economy and sustainable approach of reusing treated wastewater for irrigation.*
- *To be aware of the quality issues that need to be guaranteed to reuse treated wastewater for crop irrigation.*
- *To know how to select efficient, cost-effective and sustainable ternary and quaternary treatments.*

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Lecture #P7- Mercury in Your Environment: Steps You Can Take

Małgorzata Rutkowska, malrutko@pg.edu.pl

Syllabus

1. The challenges posed by mercury contamination in the environment and its presence in everyday items.
2. The importance of monitoring mercury in various sample types, including environmental and industrial sources, supported by a film demonstration of a mercury detection method.
3. The necessity of consistent mercury monitoring to mitigate its adverse effects.
4. Practical solutions for reducing the release of mercury into the environment in daily activities will also be discussed.
5. Attendees will gain actionable insights into minimizing their contribution to mercury pollution.

Outcomes

1. **Increased Awareness of Mercury in Everyday Life**
   Participants will develop a deeper understanding of the presence of mercury in common household items and its broader environmental implications.
2. **Knowledge of Monitoring Techniques**
   Attendees will gain familiarity with methods for mercury detection and analysis in various sample types, including environmental and industrial sources, enhanced through a demonstration film.
3. **Understanding the Need for Continuous Monitoring**
   The lecture will emphasize the critical role of ongoing mercury monitoring to mitigate its environmental and health impacts, fostering a proactive approach to pollution management.
4. **Practical Strategies for Reducing Mercury Release**
   Participants will learn actionable steps to minimize mercury emissions in their daily lives, contributing to a reduction in its harmful effects on ecosystems.

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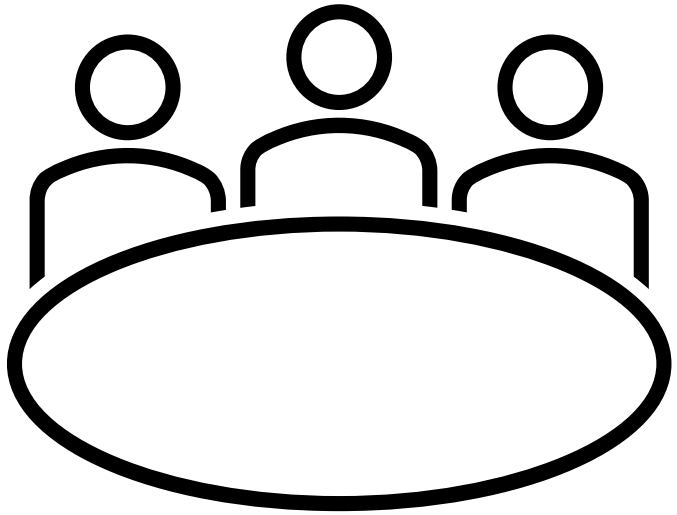

Projects

Project #1- Development of green adsorbents and their integration with advanced processes for diverse environmental applications

Supervisors:

M ª Angeles Sanromán Braga, sanroman@uvigo.gal

Marta Pazos Curras, mcurras@uvigo.gal

Outcomes

By completing this laboratory-based project, students will:

- *Acquire hands-on expertise in preparing green adsorbents and using them to remove recalcitrant organic compounds from water.*
- *Understand and apply Fenton-based regeneration processes to restore adsorbent materials for reuse in multiple water treatment cycles.*
- *Evaluate adsorption and regeneration performance, analyzing efficiency, capacity, and sustainability of the materials and processes.*
- *Develop practical skills in integrating experimental techniques with environmental sustainability assessments and optimization strategies.*

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Project #2- Circular economy solutions for the food industry

Supervisors:

Pavel Diviš, divis@fch.vut.cz

Jaromír Pořízka, porizka@fch.vut.cz

Outcomes

- *Increased awareness of circular economy principles*
- *Collaborative learning experience*
- *Hands-on understanding of food systems*
- *Critical thinking and problem-solving skills*

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Project #3- Carbon paper-based sensors for pharmaceutical pollutants: Novel green tools to surveil

Supervisors;

Simone Morais, sbm@isep.ipp.pt

Outcomes

- *Practical skills in sensor design and development*
- *Develop critical thinking skills to evaluate and integrate nanomaterials into the creation of advanced analytical tools for environmental monitoring*
- *Build in-depth knowledge about contaminants of emerging concern, their environmental impact, and the need for innovative detection methods.*
- *Foster teamwork and interdisciplinary collaboration through this laboratory-based project focused on real-world environmental challenges*

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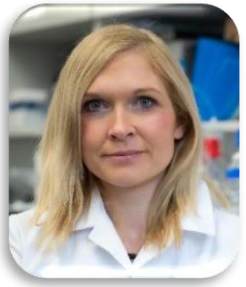
Project #4- Evaluation of the Green Character and Applicability of Analytical Procedures Using Existing Tools, with a Proposal for a New Tool



Supervisor:

Justyna Płotka-Wasylka, malrutko@pg.edu.pl

Outcomes

- *Critical evaluation of existing tools:*
- *Comprehensive evaluation of ComplexGAPI, AgreePrep, and BAGI in the context of their effectiveness and scope.*
- *Identification of specific limitations, such as lack of metrics for biodegradability, energy efficiency, or adaptability to diverse analytical techniques.*
- *Development of a new analytical tool:*
- *Proposal for a conceptual framework that includes expanded metrics for assessing the environmental impact and efficiency of analytical procedures.*
- *Introduction of a user-friendly decision-support system to evaluate and compare methods based on their green chemistry characteristics.*
- *Inclusion of novel parameters, such as recyclability of materials, real-time waste assessment, and energy consumption quantification.*
- *Enhanced methodology selection:*
- *A practical resource for researchers and practitioners to identify greener, more efficient analytical methods.*
- *Improved compatibility with a wider range of techniques and adaptability to diverse laboratory settings.*
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Project #5- Extraction of bioactive compounds from food processing waste

Supervisor:

Anna Witek-Krowiak, anna.witek@pwr.edu.pl

Outcomes

- *Identification of the most effective green extraction method for bioactive compound recovery from the selected food processing waste.*
- *Quantitative and qualitative data on the yield and composition of extracted bioactive compounds (e.g., phenolics or carotenoids).*
- *Assessment of the potential applications of the extracted compounds in industries such as food, cosmetics, or pharmaceuticals.*
- *Enhanced understanding of the environmental and economic benefits of waste valorization for sustainable development.*

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Project #6- Life Cycle Analysis- application to a case study

Supervisor Florinda Martins, ffm@isep.ipp.pt

Outcomes

- *Evaluate a real-world case study*
- *Understanding of LCA principles, framework and familiarity with LCA standards*
- *Use LCA software tools such as OpenLCA to perform assessment*
- *Critical Thinking for Decision-Making to support sustainable product design, policy recommendations, and business strategies*
- *Assess key metrics, such as carbon footprint, water use and pollution, resource depletion and ecosystem impact*
- *Interdisciplinary Collaboration: integrate LCA into broader disciplines*

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