



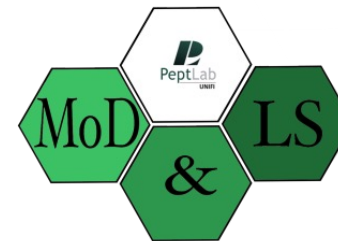
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PeptLab
INTERDEPARTMENTAL RESEARCH
UNIT OF PEPTIDE AND PROTEIN
CHEMISTRY AND BIOLOGY



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FIRENZE

**Scuola di
Economia e
Management**



Molecular Diagnostics & Life Sciences

MODELS

Laboratorio co-finanziato
con i fondi FAS 2010-2013

The Visionary approach of Education in Susbus

The new perspectives of Sustainable Chemistry



Anna Maria PAPINI, PhD



www.peptlab.unifi.it

LIFE18 ENV/IT/000460 – Life MILCH

Mother and Infant dyads: Lowering the impact of endocrine disrupting Chemicals in milk for a Healthy Life

Beneficiario coordinatore: Prof. Paola Palanza

Beneficiari associati:



European
University for
Well-Being



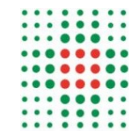
UNIVERSITÀ DI PARMA



Università degli Studi
Cagliari



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FIRENZE



**SERVIZIO SANITARIO REGIONALE
EMILIA-ROMAGNA**

Azienda Unità Sanitaria Locale di Reggio Emilia
IRCCS Istituto in tecnologie avanzate e modelli assistenziali in oncologia



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UNIVERSITÀ
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FIRENZE

Scuola di
Economia e
Management

Bachelor of Science in
Sustainable Business
for Societal Challenges
A EUniWell (& EU) degree

euni
well European
University for
Well-Being

Europe's global approach to cooperation in Research & Innovation

- ✓ Strategic
- ✓ Open
- ✓ Reciprocal

EU shall take a leading role in supporting International R&I partnerships

EU shall deliver innovative solutions to make our societies

- ✓ Green
- ✓ Digital
- ✓ Healthy

The response to the pandemic

More open science

- ✓ Sharing data and results
- ✓ Global critical mass of R&I to find solutions to global challenges

Researchers shall cooperate across borders as easily as possible

We need EU as a clear framework

- ✓ to afford issues, i.e., ethical and people-centred research
- ✓ Fair treatment of IP property and reciprocal access to research programmes
- ✓ We will have to actively engage with partners sharing these values and principles

Inter- and cross-disciplinary education
The Visionary approach in SusBus
Anna Maria Papini, Luca Rosi, and Claudia Bello



1st Year - 2nd SEMESTER
Selection of 12 ECTS

Sustainable, environmental chemistry and technology for circular economy
(with Lab)

3rd Year - 2nd SEMESTER
Selection of 12 ECTS

Industrial chemical processes for pollution prevention and control
(with Lab)

International regulatory harmonization policy for sustainable chemicals industries
(with Lab)

Opportunities of SusBus students

- **Understanding and managing the economic and social transition towards more sustainable business**
- **Developing and supporting new business models, combining profit and social interests, such as technological development and environmental protection**
- **Contributing to further development of existing firms, helping them to face the challenges of the green transition**
- **Interacting with the EuniWell network to become real “EU citizens” in a global world that is changing**



CAREER OPPORTUNITIES

- **Social Innovator**
- **Environmental Manager**
- **Chief Sustainability Officer**
- **Safety Health Environmental Manager**
- **Well-Being Tourism Manager**

And many more.....

“New green professional opportunities”

(the ones we do not know yet...)

- **Providing a framework and tools (amongst which also languages) to rationally catch the job market needs for a sustainable life full of wellness**

- <https://targetjobs.co.uk/careers-advice/job-descriptions/279465-environmental-manager-job-description>;
- <https://www.eco.ca/training/career-proles/environmental-manager/>
- <https://green-careers.usgbc.org/careers/chief-sustainability-officer/>; <https://www.forbes.com/sites/stevedenning/2011/09/27/does-your-rm-need-a-chief-sustainability-officer/>
- <https://lnu.se/en/research/searchresearch/research-projects/project-advancing-understanding-of-well-being-tourism/>

What has chemistry to do with it?

The **characteristics of the molecule govern the physicochemical properties of the compound** which in turn influences transformation and distribution in the environment and the biological effects: the transformation and distribution in the environment as well as biological effects can be *predicted* from the characteristics of the molecule and the physicochemical properties of the compound.

CHARACTERISTICS OF THE MOLECULE
(e.g. molecular weight, functional groups, chemical bonds, surface area)



PHYSICOCHEMICAL PROPERTIES OF THE MOLECULE
(e.g. aqueous solubility, melting point, lipophilicity)



TRANSFORMATION AND DISTRIBUTION IN THE ENVIRONMENT
(e.g. persistence, bioaccumulation)



BIOLOGICAL EFFECTS
(e.g. toxicity, reduction in growth, reduction in reproduction)

SUSTAINABLE, ENVIRONMENTAL, CHEMISTRY AND TECHNOLOGY FOR CIRCULAR ECONOMY

AA 2023-2024
2nd semester
12 ECTS

4 ECTS module:

CHARACTERISTICS OF MOLECULES

RELATIONSHIP BETWEEN MOLECULAR STRUCTURE AND PHYSICAL AND CHEMICAL PROPERTIES (with example taken from everyday life)

CORRELATION WITH THE EFFECT IN THE ENVIRONMENT(why a compound can be considered a pollutant)

THE ENERGY PROBLEM, WHICH SOLUTIONS?

Biodegradation Technologies based on enzymes and microorganisms for the treatment of polluted areas

Virtual laboratories (with case studies):

Organic molecules and sustainability.

Description and interpretation of an MSDS.

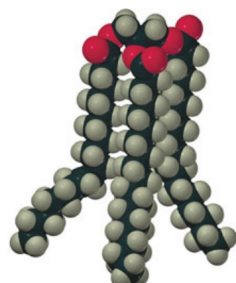
Integrating bioremediation and biofuel production

Why do we care about the geometry of molecules?

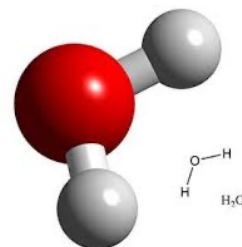
Molecular geometry, also known as the molecular structure, is the three-dimensional structure or arrangement of atoms in a molecule. *Understanding the molecular structure of a compound can help determine the polarity, reactivity, phase of matter (boiling and melting points), color, magnetism, as well as the biological activity.*



A fat = solid

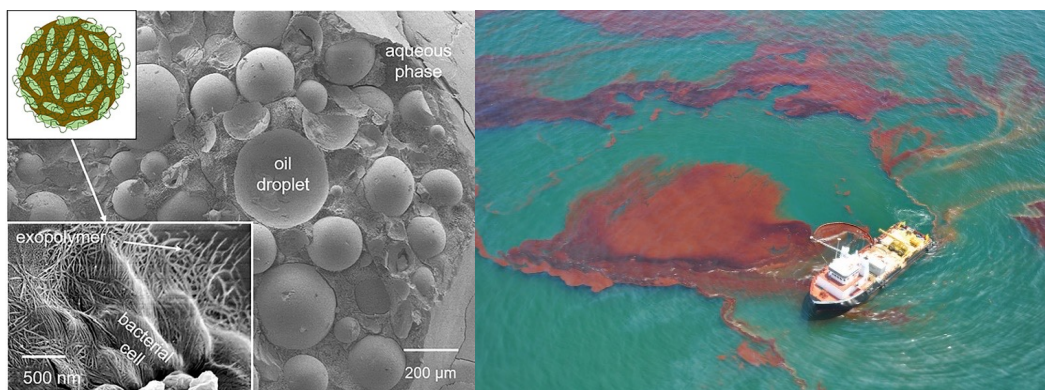


An oil = liquid



The shape of snow flakes?

Biodegradation and Bioremediation



Degradation of pollutant oil happens at water-oil interface and oil-atmosphere interface. Bacteria such as *Alcanivorax borkumensis* can efficiently disperse and degrade oil: a green way in oil spill remediation

Fig from: Marzhana Omarova et al **Biofilm Formation by Hydrocarbon-Degrading Marine Bacteria and Its Effects on Oil Dispersion** *ACS Sustainable Chemistry & Engineering* 2019 7 (17), 14490-14499

SUSTAINABLE, ENVIRONMENTAL, CHEMISTRY AND TECHNOLOGY FOR CIRCULAR ECONOMY

AA 2023-2024
2nd semester
12 ECTS

4 ECTS module:

Biomolecules and biopolymers

Environmental pollutants in biological, food, and environmental matrices: the Endocrine Disruptor Chemicals (EDCs)

Virtual laboratories: case studies

- Biopolymers and novel applications for real bioplastics
- Ecodesign of a biomolecule
- Introduction to Good Manufacturing Practices (GMP) of Active Ingredients
- Replacing non eco-friendly plasticizers

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LIFE18 ENV/IT/000460 – Life MILCH
**Mother and Infant dyads: Lowering the impact of endocrine
disrupting Chemicals in milk for a Healthy Life**

euni European
well University for
Well-Being

The New Disease Paradigm
Developmental Origins of Health and Disease (DOHaD)

A bad start...lasts a lifetime!

Impact of the environment during development:

- Maternal-Fetal Stress
- Fetal-Infant Nutrition
- Chemicals in the Environment
- Permanently change cell, organ and system function

Epigenetic changes are a plausible mechanism for permanent functional and transgenerational effects





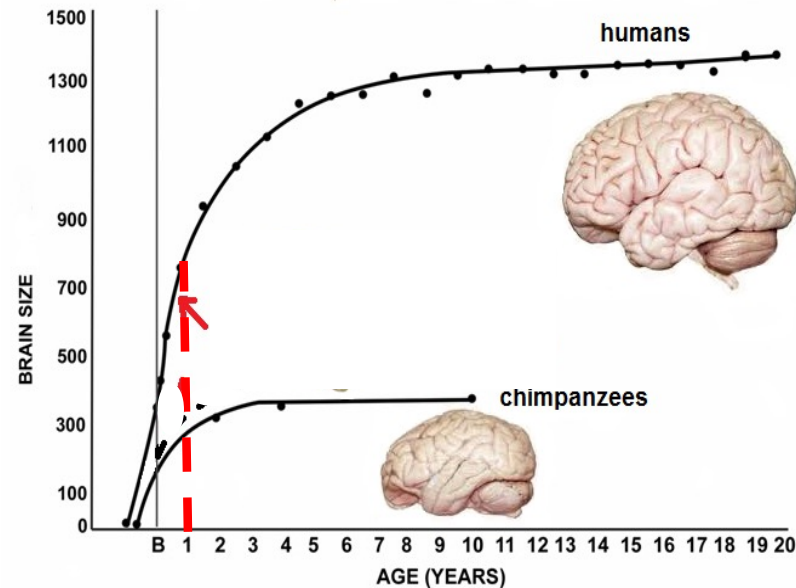
LIFE18 ENV/IT/000460 – Life MILCH

Mother and Infant dyads: Lowering the impact of endocrine disrupting Chemicals in milk for a Healthy Life

The mother-child couple is a target sensitive to exposure to chemical compounds present in the environment



I bambini nascono a uno stadio di sviluppo precoce – «*the 1st year brain spurt*»



7 Groups of Endocrine Disruptors Chemicals

Group A: Bisphenols

Group B: Parabens

Group C: (11 analytes) = polycyclic aromatic hydrocarbons (PAHs)

Group D: Pesticides

Group E: Pthalates

Group F: Insecticide Pyrethroid

Group G: Metals



LIFE18 ENV/IT/000460 – Life MILCH
**Mother and Infant dyads: Lowering the impact of
endocrine disrupting Chemicals in milk for a Healthy Life**



Correlation between levels of Endocrine disrupting chemicals (EDCs)

contamination in humans, determining their presence (and metabolites) **in biological fluids** and **impact on health particularly in infants** (general health status, cognitive development, metabolic regulation, development of intolerances and allergies, etc.).

Evaluating the **risk of health damage** from exposure to EDCs among the population, and particularly among young women.

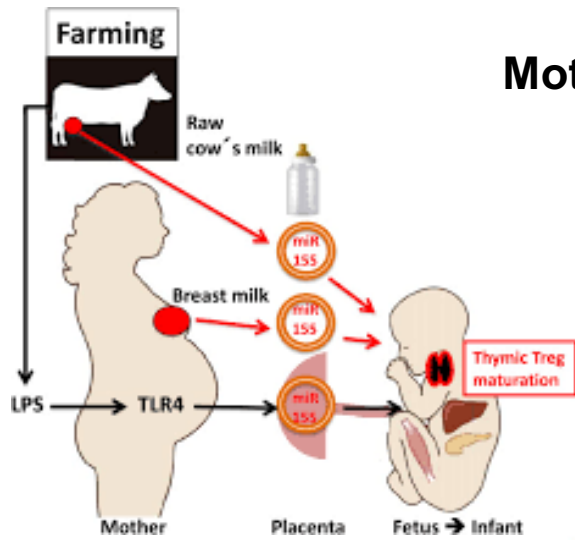


EU-approved Reliable Chemical analyses on the different biological matrices is a challenge

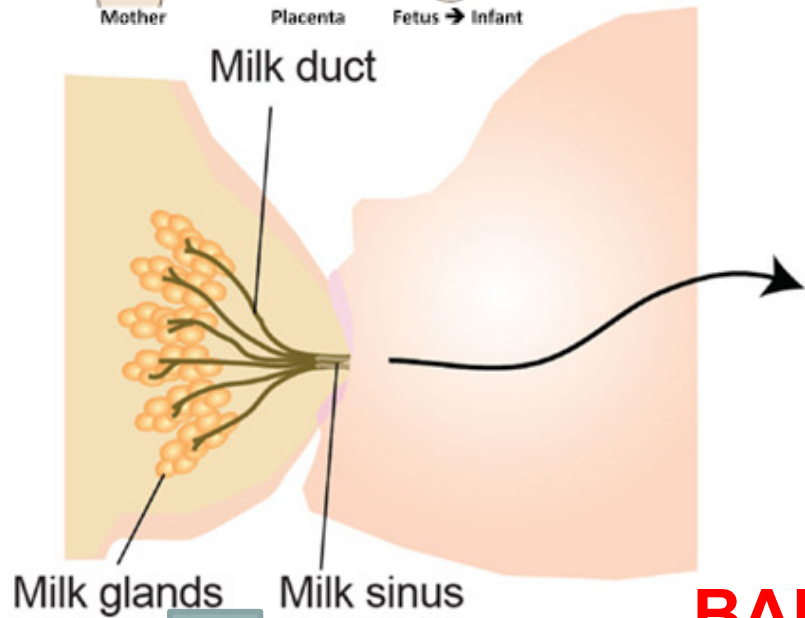
EU Identification of internal standards as unequivocally characterized synthetic EDCs and metabolites have to be used for quantitative determination in human biological fluids.

EU-approved Specific instrumentation techniques (i.e. **HPLC-MS, ICP-AES, GC-MS**) valid, reproducible, efficient, and sensitive methods to quantify specific EDCs and metabolites in human biological fluids.

Mother and Infant dyads: Lowering the impact of endocrine disrupting Chemicals in milk for a Healthy Life

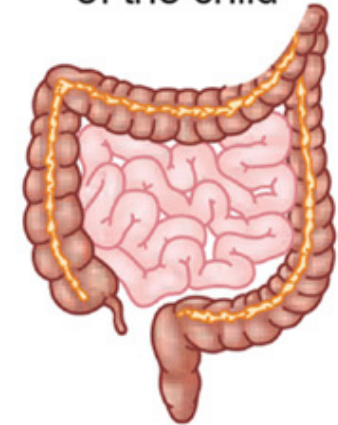


GOOD CHEMICALS



- Breast milk
- Extracellular vesicles
 - Prebiotics
 - Probiotics
 - Cytokines
 - Antigens
 - Cells
 - Antibodies

Intestinal immunity of the child



BAD CHEMICALS

AS

ENDOCRINE DISRUPTING CHEMICALS FROM THE ENVIRONMENT



The 5Es main challenges that hinder the implementation of bioplastics

Economics

Currently more expensive to produce

Efficiency

Manufacturing processes can be less energy efficient and come with other environmental burdens (agricultural farming).

End of life

Recycling streams have yet to be established to make them truly 'circular'.
Consumers remain uncertain of how to deal with bioplastics after use. Compostable bioplastics are often rejected by composters.

Ethics

Using first-generation biomass (often edible), remains controversial.

Education

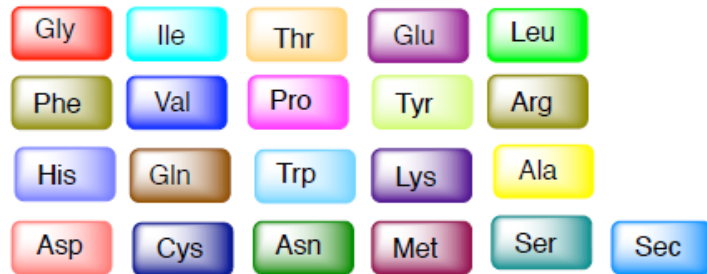
Consumers and plastic converters are confused about the usefulness of bioplastics, (greenwashing).

Proteins

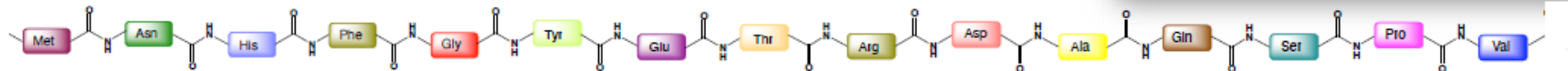
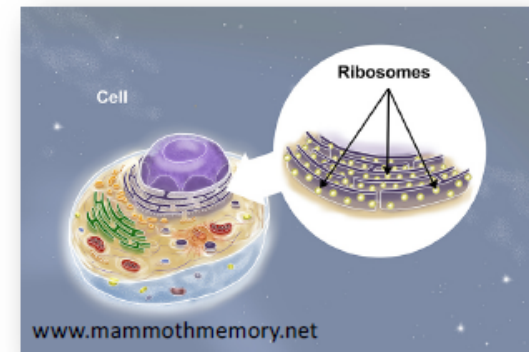
Natural Sustainable Biopolymers

What are proteins?

- Biomacromolecules assembled from the 20+1 proteinogenic amino acids

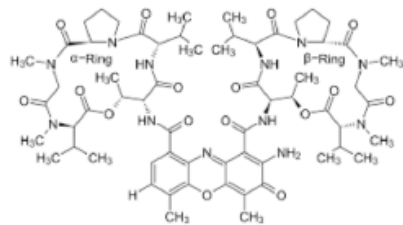
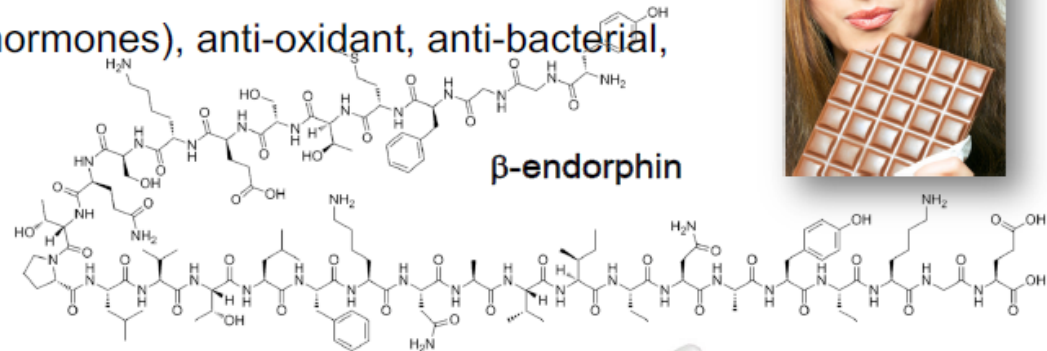
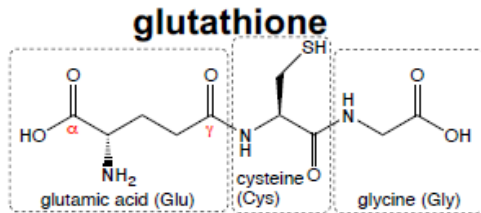


- Genes determine amino acid sequence
- Enzymes (proteins) help to synthesize proteins



What are peptides?

- Peptides are smaller than proteins (usually <50 amino acids)
- Usually no defined structure
- Various functions: signaling molecules (hormones), anti-oxidant, anti-bacterial, anti-inflammatory

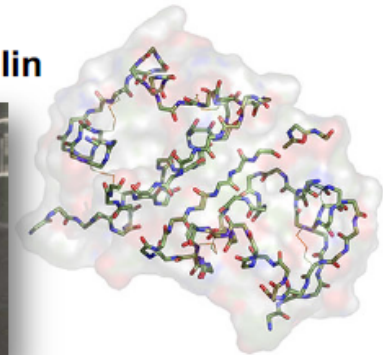


Actinomycin D

insulin



Dorothy Hodgkin



ZU KOIN



What makes peptides interesting molecules?

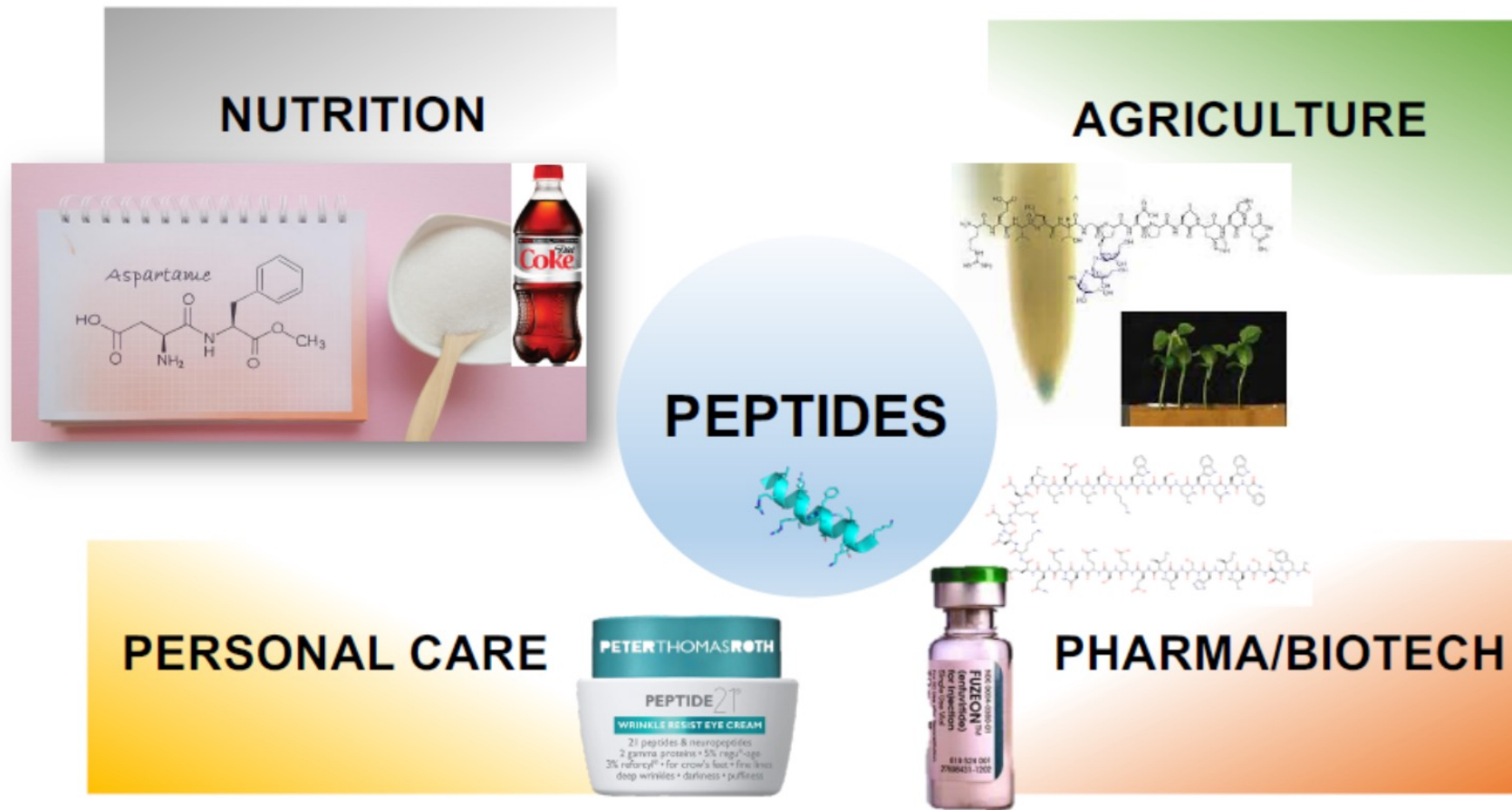
↳ Compared with small organic molecules

- high efficacy, selectivity and specificity
- degradation products: amino acids lower risks of systemic toxicity
- short half-life: no accumulation in tissues, lower risk of complication from metabolites

↳ Compared with proteins or antibodies

- Smaller: higher tissue diffusion
- lower toxicity or immunogenicity
- Lower cost

Domains in which peptides are developed



5th EUniWell SEED FUNDING CALL

**euni
well** European
University for
Well-Being

Technology Transfer of Peptides for the Well-being Economy TTPep - Peptides for Well-being

TTPep aims to promote peptides

Educating new generations in this emerging field of natural molecules with high impact for health and well-being.

Specific laboratory training courses, seminars and networking workshops will develop knowledge in peptides to be translated in diagnostics, therapeutics, cosmeceuticals in a circular economy perspective



EUniWell SFC5 Workshop September 26, 2023 15:00-18:00

Erasmus Coordinator of
the School of Economics
and Management

euni
well

European
University for
Well-Being



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FIRENZE

European University Alliance



UNIVERSITY
OF COLOGNE



SEMMELWEIS
UNIVERSITY 1769

REGIONE
TOSCANA

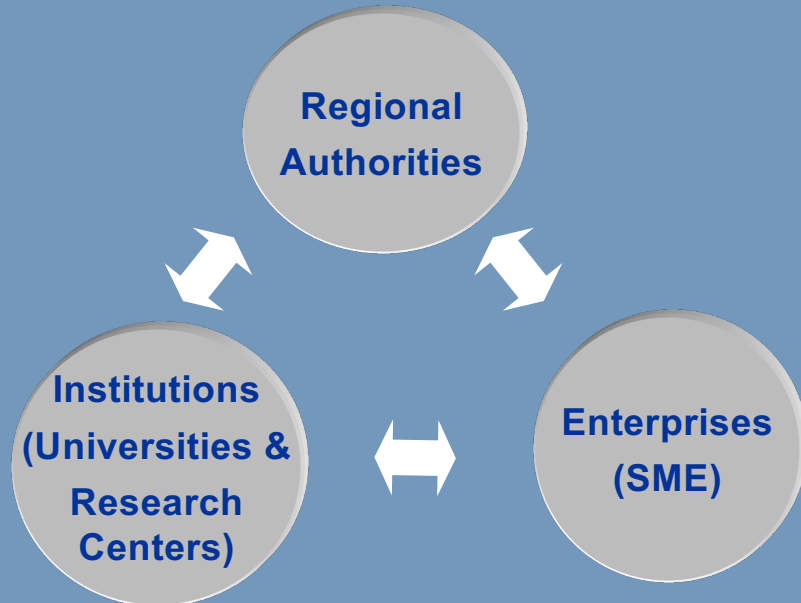


Radregion
Rheinland



Triple Helix Model

Local Stakeholders who have developed interactions for R&D activities



UNIVERSITY OF
BIRMINGHAM

 **Birmingham**
City Council

 **Nantes**
Université

 **Loire**
Atlantique



SUSBUS Career opportunities



- **Environmental Manager**
- **Chief Sustainability Officer**
- **Safety Health Environmental Manager**
- **«New green professional opportunities»**

- **We can provide a framework of tools (amongst them also languages) to rationally catch the job market needs for a sustainable life**

- **Fostered by Erasmus+ Mobility in EUNIWELL Network**

Translational research and technology transfer at the University of Florence to develop sustainable products



Image source: The U.S. National Institutes of Health (NIH)



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PeptLab

INTERDEPARTMENTAL RESEARCH
UNIT OF PEPTIDE AND PROTEIN
CHEMISTRY AND BIOLOGY

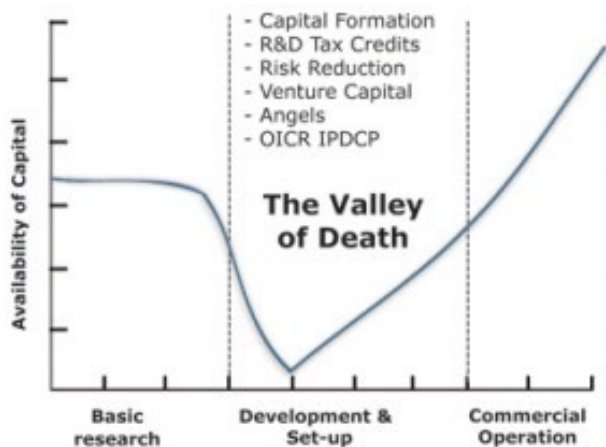
REGIONE
TOSCANA



**SINCE
2003**



2007-2014

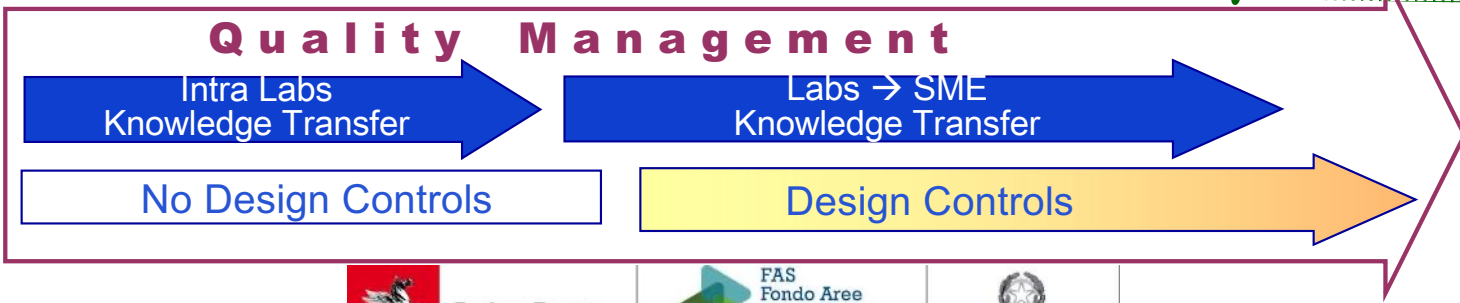
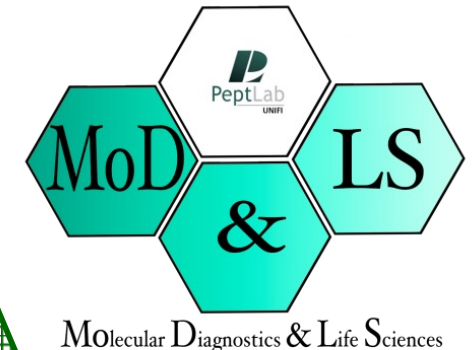
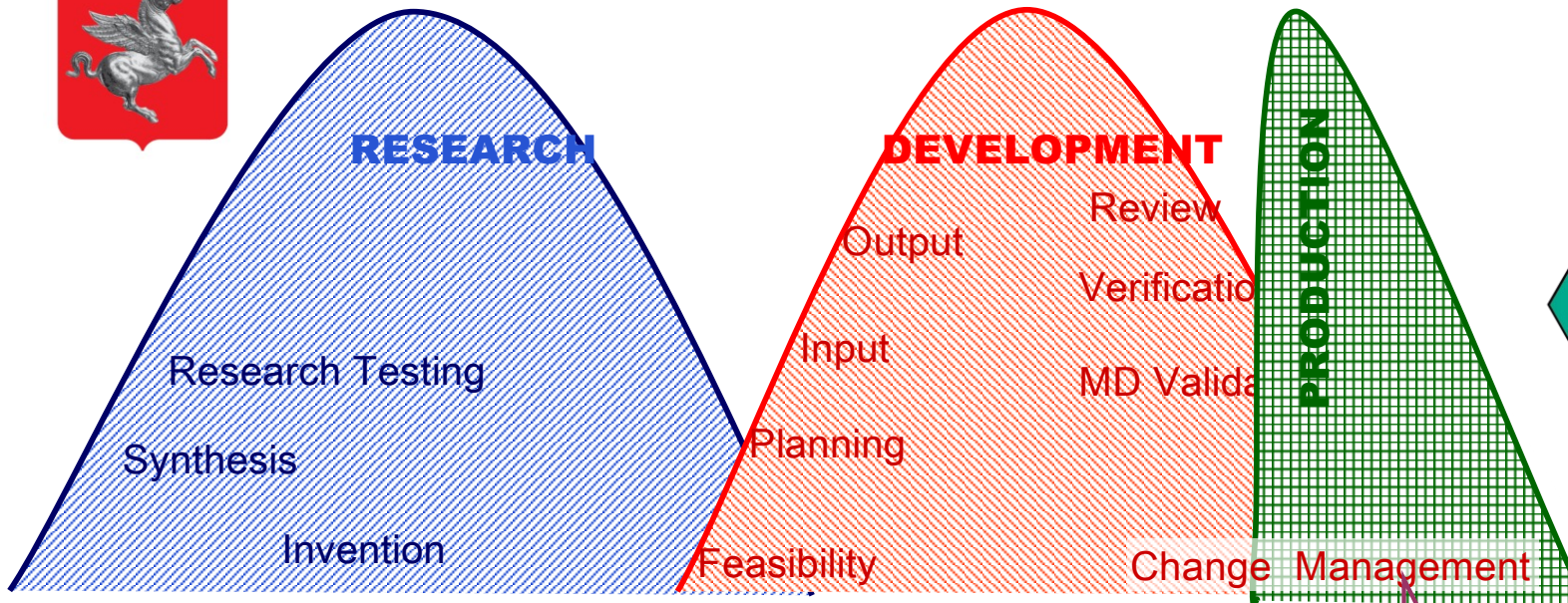


2017-2020



Approach to favour R&D in SMEs

REGIONE
TOSCANA

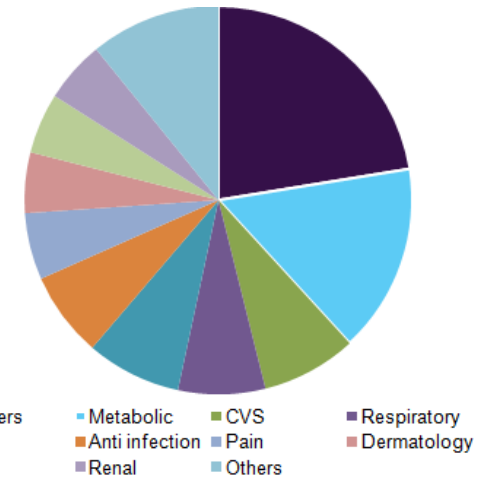


Industry Insight

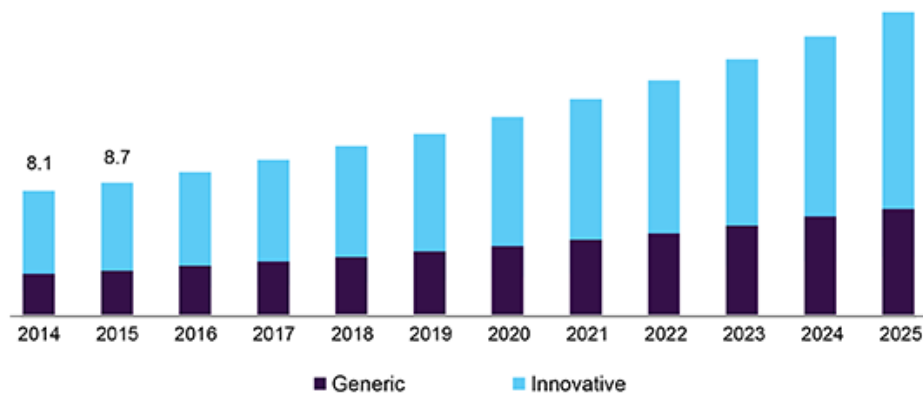
Global Peptide Therapeutics Market

Challenges

- ✓ Generic vs innovative peptide drugs
- ✓ The loss of patents of branded drugs
- ✓ High demand for efficient & low-cost alternatives for blockbuster peptide drugs
- ✓ Advancements in processes of manufacturing peptides



U.S. peptide therapeutics market size, by drug type, 2014 - 2025 (USD Billion)



Compound Annual Growth Rate 9.4%

Source: www.grandviewresearch.com

The strategy of TT from Academic spin-off to API manufacturer to manage GMP production of peptides

PeptFarm

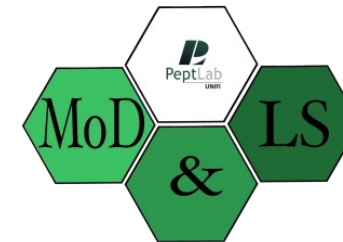
PeptFarm is a PeptLab Facility inside the Sesto Fiorentino campus of the University of Florence (www.peptlab.unifi.it)



Education
Research &
Technology
Transfer in
Peptides



DICUS
DIPARTIMENTO DI CHIMICA
LUIGI SCHIFFI
NEUROFARBA
DIPARTIMENTO DI NEUROSCIENZE,
PSICOLOGIA, AREA DEL FARMACO
E SALUTE DEL BAMBINO



Molecular Diagnostics & Life Sciences



Regione Toscana



In 2017-2020 FIS - Fabbrica Italiana Sintetici joined **PeptFarm** to transfer the technology to produce GMP peptide APIs

Outsourcing of Active Pharmaceutical Peptide Ingredients production will boom if Academic Spin-off Companies are competitive!



PeptFarm



synthetic process

polluting strategy

scalable → cGMP-ready

transfer: from multi



G. Sabatino, A. D'Ercole, L. Pacini, M. Zini, A. Ribecai, A. Paio, P. Rovero, A.M. Papini. An Optimized Scalable Fully Automated Solid-Phase Microwave-Assisted cGMP-Ready Process for the Preparation of Eptifibatide. *Org Proc Res & Dev* 2021 Doi.org/10.1021/acs.oprd.0c00490

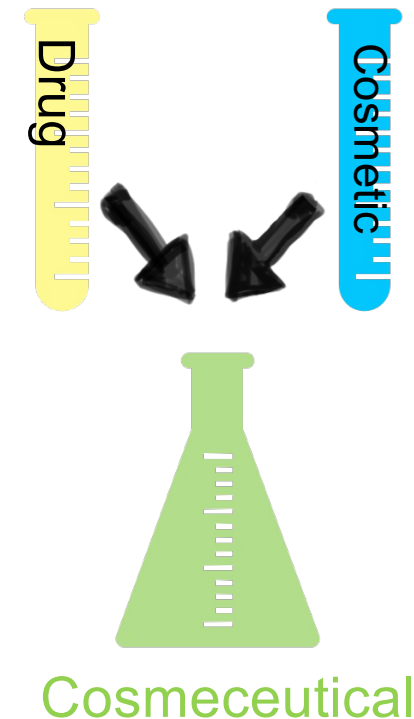
KP1: the lucky journey of a peptide from the University to the cosmetic market

What is a cosmeceutical?

The grey line
between a pharmaceutical and a cosmetic product

Specific benefits of a cosmetic formulation

- ✓ Anti-ageing
- ✓ Hyper- or hypomelanogenesis
- ✓ Lifting effect



**NO CHARACTERISED PEPTIDE
NO SCIENTIFIC STUDIES VERIFYING BIOLOGICAL ACTIVITY**

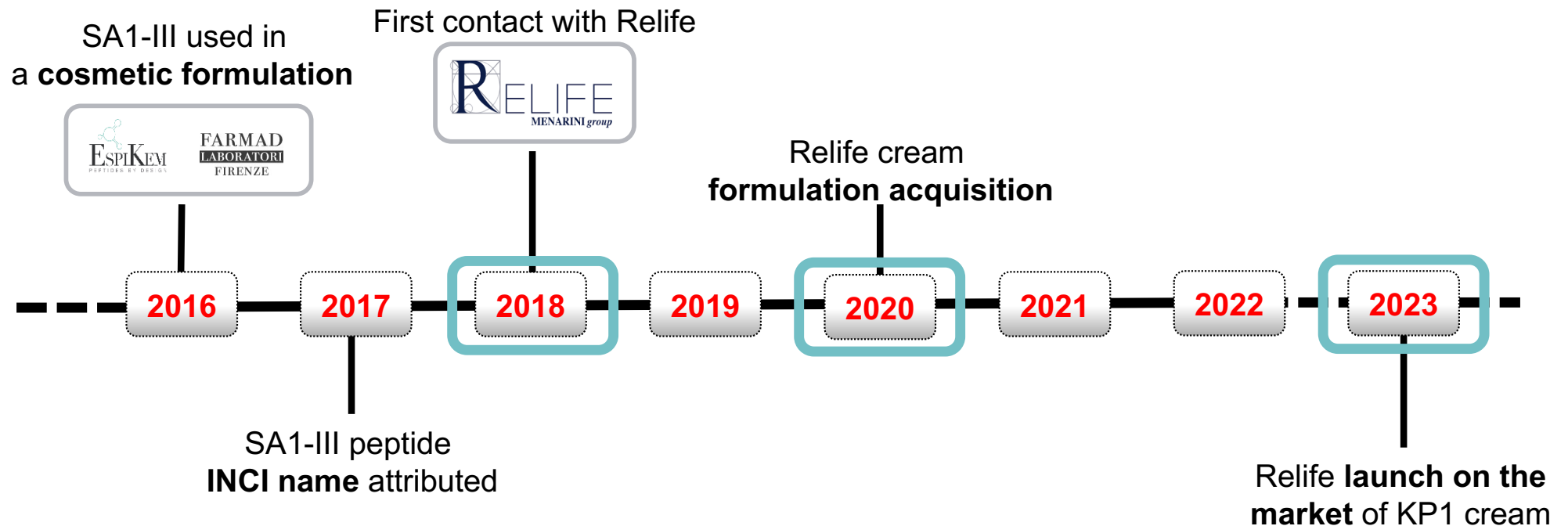


**Rénergie H.P.N.
300-Peptide Cream**

INGREDIENTS

AQUA / WATER / EAU · GLYCERIN · DIMETHICONE · CETEARYL ALCOHOL · THEOBROMA GRANDIFLORUM SEED BUTTER · ALCOHOL DENAT. · CETEARYL ISONONANOATE · NIACINAMIDE · GLYCERYL STEARATE · PEG-100 STEARATE · ISOPROPYL PALMITATE · OCTYLDODECANOL · CYCLODEXTRIN · **HYDROLYZED LUPINE PROTEIN** · PISUM SATIVUM EXTRACT / PEA EXTRACT · ADENOSINE · CAPRYLOYL SALICYLIC ACID · HYDROLYZED HYALURONIC ACID · **HYDROLYZED LINSEED EXTRACT** · PENTAERYTHRITYL TETRA-DI-T-BUTYL HYDROXYHYDROCINNAMATE · TRISODIUM ETHYLENEDIAMINE DISUCCINATE · TOCOPHERYL ACETATE · CERA ALBA / BEESWAX / CIRE D'ABEILLE · ORBIGNYA OLEIFERA SEED OIL · SIMMONDSIA CHINENSIS BUTTER / JOJOBA BUTTER · CETEARYL GLUCOSIDE · CITRIC ACID · HYDROXYETHYL ACRYLATE/SODIUM ACRYLOYLDIMETHYL TAURATE COPOLYMER · POLYSORBATE 60 · POTASSIUM CETYL PHOSPHATE · SORBITAN ISOSTEARATE · TOCOPHEROL · DIMETHICONE/POLYGLYCERIN-3 CROSSPOLYMER · BENZYL ALCOHOL · GERANIOL · LIMONENE · CHLORPHENESIN · DIPROPYLENE GLYCOL · PHENOXYETHANOL · SODIUM BENZOATE · PARFUM / FRAGRANCE · (F.I.L. T7001 81 37/2)

Time-table



September 23rd 2023

Milan, Italy

Relife launches
a new line of cosmetic products:
Definisse [KP¹][®]



Definisse [KP¹][®]

Collagen Modulator Bio-Peptide

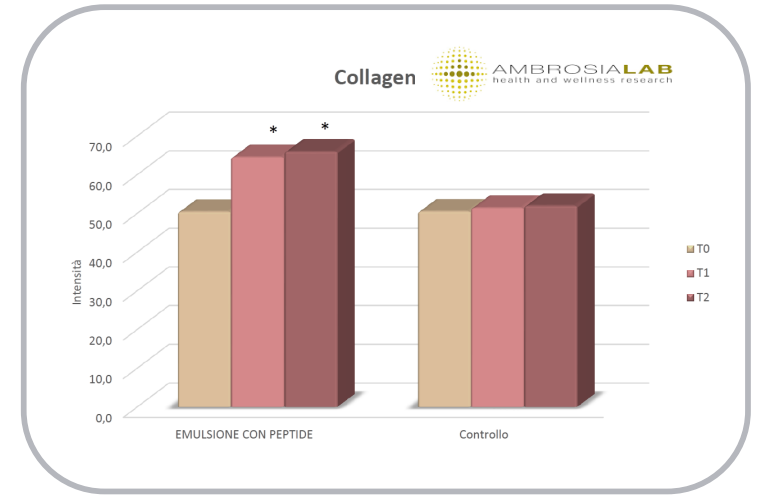
Rovero et al., *Clin Cosmet
Investig Dermatol*, 2022



Modified SA1-III sequence



“best in class”, part of new negotiation with other partners



Time-table From First-in-class To Best-in-class

AAT11RI peptide
INCI name attribution
and **clinical studies**



Italian
patent
application
for
AAT11RI

International patent
for AAT11RI

International **patent** WO 2020/245772 A1
(PCT/IB2020/055291) F. Errante, L. Giovannelli, A.M. Papini,
P. Rovero. Applicants: Espikem Srl, Università di Firenze.



Inventors

Efficacy evaluation *in vivo*

The strategy for Technology transfer

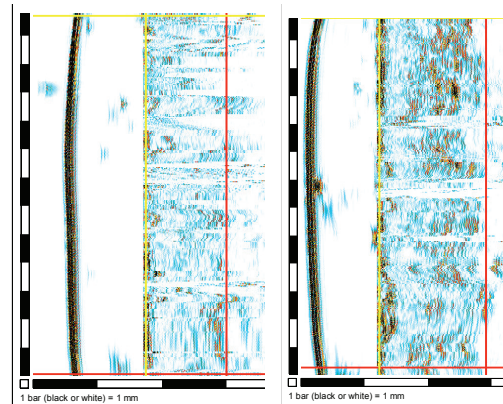


Figure 1. Ultrasonographic analysis of a representative subject, after topical application of peptide SA1-III based cream on the face twice daily. Left panel: t = 0; right panel: t = 21 days.

High-frequency ultrasonographic evaluation: a modern, non-invasive method to reliably assess dermal condition in real-time

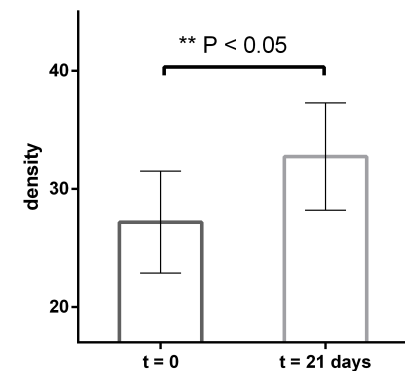


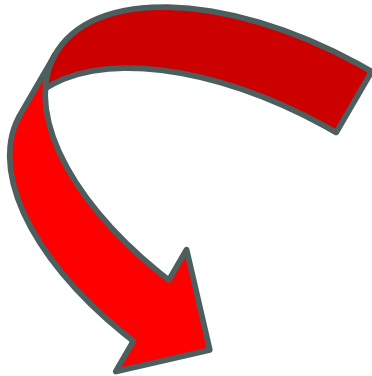
Figure 2. Variation of subepidermal low echogenic band (SLEB) density, proportional to the protein content of the dermis, after 21 days of treatment with peptide SA1-III cream.

Definisse

[KP¹]

LA PRIMA ARMA VERAMENTE EFFICACE CONTRO LE RUGHE

2017-07-21-VIDEO-0000027.mp4



RELIFE
MENARINI group


ESPIKEM
PEPTIDES BY DESIGN
www.espikem.com

UNIVERSITÀ
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FIRENZE

Launched in EU
on September 22-23, 2023 (MI, IT)



Inventors: Errante F., Giovannelli L., Papini A.M., Rovero P. "Bioactive peptides and compositions comprising them". International PCT n. IB2020/055291. Priority 07/06/2019.
Applicants: Espikem Srl (80%), Università di Firenze (20%).

• SUSTAINABLE, ENVIRONMENTAL, CHEMISTRY AND TECHNOLOGY FOR CIRCULAR ECONOMY

AA 2023-2024

2nd semester

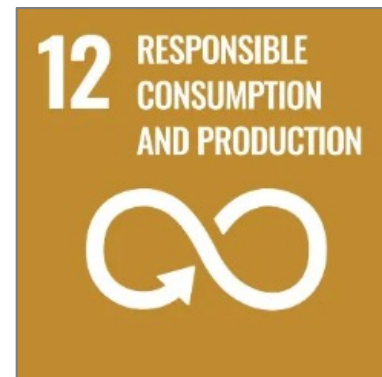
12 ECTS

• 4 ECTS module:

- Recalls of Chemical processes based on fossil sources: petroleum and petrochemicals.
- Introduction to The Circular Economy.
- Introduction to the concept of biorefinery and to the concept of Green Chemistry. Waste and by-products as feedstock for biorefinery of Second-generation.
- Technical-economic evaluation of biochemical and thermochemical biorefineries.
- Types of biorefineries. Design, engineering and process of biorefining plants (entry level).
- Biorefineries focused on bioethanol.
- Chemicals from Biomass: platforms for production from lignocellulosic biomass of biochemicals and biopolymers.

The 17 **Sustainable** Development Goals (SDGs) are the world's best plan to build a better world for people and our planet by 2030. Adopted by all United Nations Member States in 2015, the SDGs are a call for action by all countries – poor, rich and middle-income – to **promote prosperity while protecting the environment.**

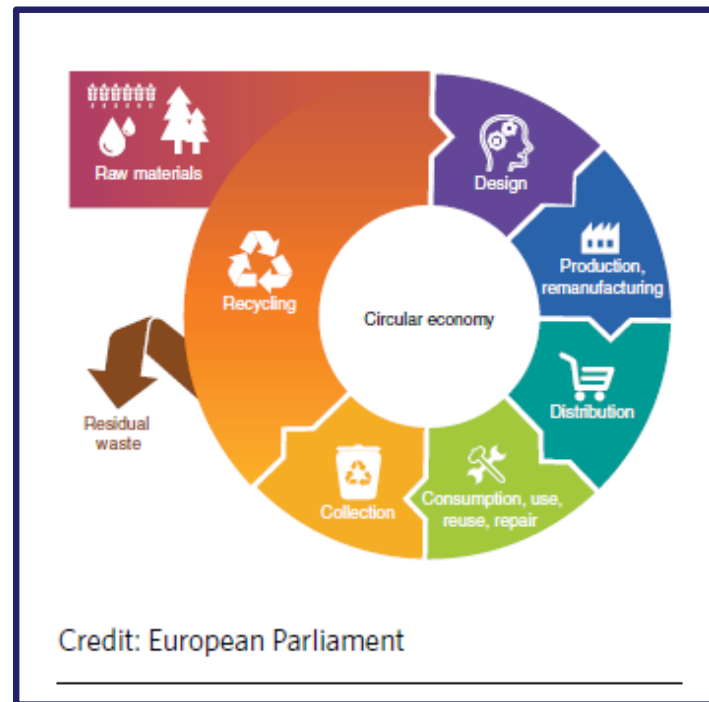
The most important goal for us is goal 12



How can we achieve this goal?

There are many actions we can take. The main ones are:

- Use **renewable raw materials** instead of fossil-based raw materials.



- **Recycle** by-products of production processes
- Design **recycling strategies for end-of-life products**, as well as developing **less energy-intensive processes**.



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Thank You



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