epnoe

European Polysaccharide
Network Of Excellence

Upskilling of Professionals for a Sustainable Europe

Foreword

«A fool sees not the same tree that a wise man does» **– William Blake**

Education and development of skills define our way of seeing life, our interpretation of the past and our vision about the future. Our transition to a more sustainable and circular economy requires a set of new skills and competences that should be urgently implemented in our universities and school system. We are living in a time of great contradictions and growing disinformation. The picture of a scientist working alone wearing a white coat in a laboratory is far outdated. The demand for profiles of egocentric scientist is declining because it is not suitable for meeting and overcoming new challenges ahead. Millions of euros in funding for top-down research and innovation programmes are proving ineffective.

Our time calls for a new professional, with a balance of soft and hard skills and with profound understanding of sustainability and social, economic, and environmental impacts of current and future technologies. Collaborative co-creation becomes a key word for the future of science and innovation. Bottom-up initiatives with multiple actors start to emerge as a new format for creating disruption.

The EPNOE Skills Roadmap 2040 is a joint effort of polysaccharide scientists engaged in education in six European countries. It complements the EPNOE Research Roadmap 2040, aiming to facilitate a dialogue with relevant stakeholders in our society such as policy makers, politicians, funding bodies, scientists, industry, entrepreneurs, innovators, influencers, universities, and the general public. The world is changing at an unprecedented pace and the challenges to save our planet are increasing daily. We know that we can do more and do things better because we have the human and technological resources in our hands. We invite you to join this dialogue and support the implementation of the recommendations outlined in this roadmap in your institution and organisation.

This is our gift to a sustainable future of Europe.

Tiina Nypelö
EPNOE VP Education

Pedro Fardim
President of EPNOE

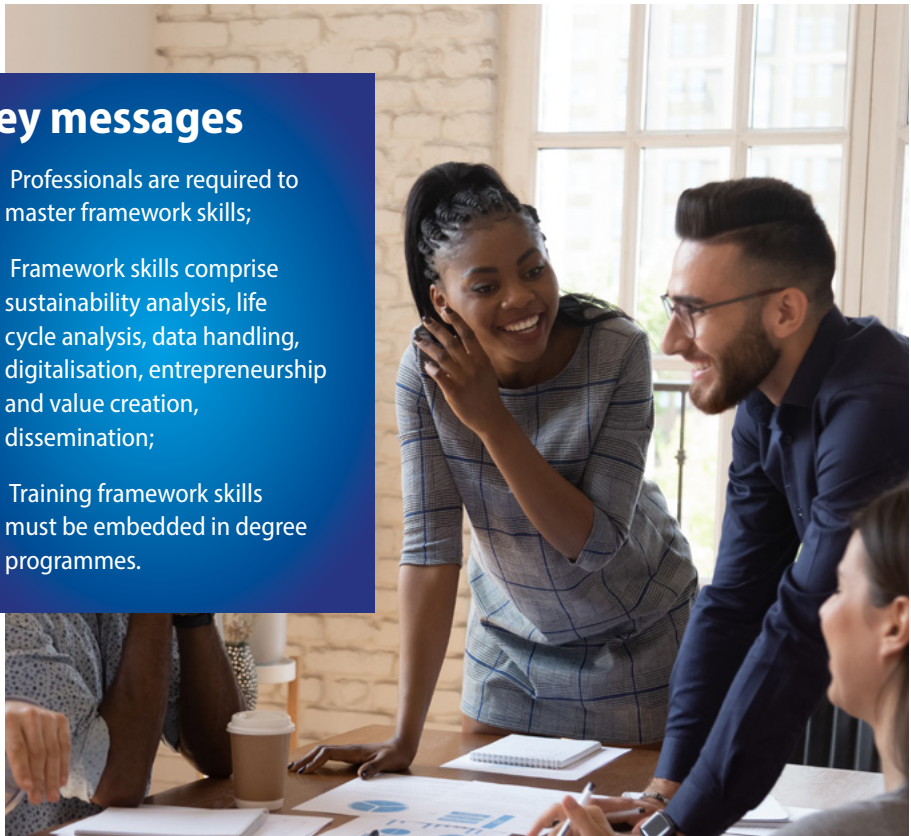
Executive summary

There are a multitude of requirements for professionals working in engineering and science fields that are relevant for sustainable and renewable future. Mastering the technological aspects of engineering and natural sciences is, of course, a core part of the skillset. However, Europe needs **professionals who are able to quantify and guide selection of processes using sustainability and life cycle analyses including social and economic impacts of current and future technologies**. This calls for a set of new **skills involving sustainability concepts, acquiring and handling data and even using artificial intelligence**. Taking innovations forward in a timely manner requires an **entrepreneurial mindset** and **skills of translating science into technology**.

Dissemination skills are central in professional life, but they involve the challenge of changing communication platforms and venues as well as need to have **skills to attune the message to diverse audiences**. The European vision must be to systematically embed education in **framework skills** such as sustainability, life cycle analysis, as well as entrepreneurship in degree programmes and ensure a holistic skillset among European professionals.

Key messages

- Professionals are required to master framework skills;
- Framework skills comprise sustainability analysis, life cycle analysis, data handling, digitalisation, entrepreneurship and value creation, dissemination;
- Training framework skills must be embedded in degree programmes.



1 Introduction

Climate change is considered to be one of the world's foremost concerns and, despite the worldwide governmental efforts in reaching a feasible agreement to maintain global temperature at acceptable levels, the scenario is hardly optimistic. Achieving the goal of keeping average global temperature below 2 °C requires a serious global commitment in shifting to zero emissions by 2050, thus targeting a dramatic and unprecedented reduction of greenhouse gas emissions. Until now, most efforts to tackle the prominent global warming crisis have been focused on energy efficiency to support the transition to renewable energy sources. In fact, the recent conflict in Europe has triggered a volatile geo-political environment that has exposed Europe's tremendous dependence on fossil fuels and its derivatives. Consequently, this has accelerated the urgency in promoting such a transition towards renewable energy in Europe and in developing sustainable alternatives to fossil-based energy and materials.

Nevertheless, it is important to remember that, despite the importance of such a transition in the energy paradigm, renewable energy can only address around 55% of emissions generated by the energy sector, while the remaining 45% derives from all the other activities, such as food production, vehicles, and textile production, and all the other day-to-day materials.[1] The fact is that prominent global economies have been favouring unsustainable linear economy models for their development, which essentially rely on 'take-make-consume-dispose' strategies, while these linear models fail to recognise one vital aspect: natural resources are limited and require time to be regenerated and to make new resources available for future consumption. Consequently, the continuous extraction, processing, use and disposal of finite natural resources have been severely affecting the planet's environments, climate, and underlying resource supply while generating massive volumes of waste.

Societal welfare is strongly linked to raw material use, but human prosperity and economic growth should not be achieved and sustained at the expense of the environment. Nevertheless, the world's population is currently consuming the equivalent of 1.75 planet Earths, a number that is scarily predicted to increase to 2 planet-equivalents by 2030.[2] The solution relies on shifting towards circular economy-based models, since this is a robust way to break the 'take-make-consume-dispose' pattern while keeping products, commodities, and resources 'in the loop' for as long as possible. It is now clear that the growth of the world's population and resource consumption, combined with the grand challenges of climate change and food scarcity, will rapidly increase the demand for products manufactured circularly from renewable and sustainable sources.

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1 https://circulareconomy.europa.eu/platform/sites/default/files/emf_completing_the_picture.pdf

2 https://www.theworldcounts.com/challenges/planet-earth/state-of-the-planet/overuse-of-resources-on-earth; https://www.footprintnetwork.org

Therefore, societies need to explore the role of bio-based materials in enabling a thriving circular economy, as this strategy is, most likely, the only sustainable approach within our planet's means. Then creating integrated production and supply chains that reduce, reuse, repurpose, recycle, and remanufacture will ultimately maximise our resource efficiency and better align economic value creation with long-term ecological wellbeing. The strategic orientation defined in Horizon Europe 2021-2024 Strategic plan is geared towards the green and digital transitions in the economy, industry, and society.[3]

It is in this context that renewable resources, polysaccharides as well as bio-based polymers, can take the lead in offering sustainable solutions to the many resource challenges of society and suppliers in the near future with relevant impact. Polysaccharides are used in every aspect of society and are considered essential components for future materials solutions. The field of polysaccharides and bio-based polymers occupies a prominent position, serving as a robust platform for finding sustainable solutions to complex global challenges.

To strengthen the competitiveness and sustainability of society, the European Commission has set a number of action plans. The updated bioeconomy strategy[4] proposes actions to scale up and deploy the bioeconomy locally, capitalising on and going beyond past successful research and innovation investment in order to create growth and job opportunities at the local level, to reinforce the bio-based sector, and to contribute to the modernisation of Europe's industry, to protect the environment and enhance ecosystems' functions and biodiversity. The contribution of polysaccharides is considered significant, being one of the most important renewable components in bio-based resources. In addition, the EU aims to be climate-neutral by 2050 – an economy with net-zero greenhouse gas emissions, as the core focus of the Green Deal.

Skilled professionals are needed to achieve the set targets of sustainability, competitiveness, and green and digital transitions. In that context, having and using the skills that are crucial for these transitions becomes of utmost importance. The ability to acquire, combine and implement knowledge and key skills is fundamental for European organisations to innovate and thrive. Nowadays, information, insight and new ideas spread tremendously fast. There is a competition for knowledge and creativity, and the logics and logistics of innovation have changed. To stay competitive, we must continuously refresh understanding of our position in the world and participate in the most relevant knowledgeable flows.

[3] https://www.eeas.europa.eu/sites/default/files/horizon_europe_strategic_plan_2021-2024.pdf
[4] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52019DC0640&from=ET

2. Horizon of skills

Defining skills that are needed to facilitate the green transition has created the foundation for this work. The European research horizon in topics related to renewable and sustainable resources and materials solutions encompasses engineering and science fields: materials science, chemistry, physics, biology, food, nutrition, and biomedical materials (See EPNOE Research Roadmap 2040, and Figure 1).

The horizon encompasses the transformation to circular bioeconomy including sustainable utilisation of raw materials, improved reusability of materials, circular processing and circular business models, and minimisation of waste and emissions. This scenario is highlighted in European and global guiding documents such as United Nations inventory of sustainable development goals and the Green Deal.[5]

Professionals with skills in fundamentals of renewable resources, demands of the current processes and manufacturing industry, skills in sustainability, circularity and economics are needed for implementing the circular economy strategies. Skills of data handling and digitalisation, entrepreneurship and value creation, and dissemination are needed for delivering the change and impact.

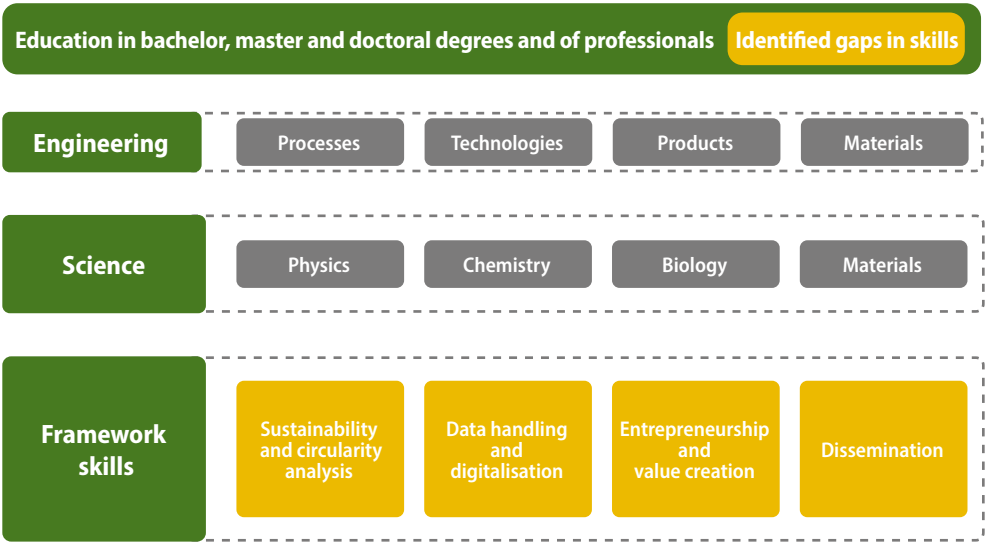

Figure 1. Mapping the horizon of skills needed for sustainable Europe.

[5] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52019DC0640&from=ET; https://unstats.un.org/sdgs/report/2022/

3. Where are we now?

3.1 Current situation

Training of future professionals is being implemented and maintained in bachelor- and master-programmes as well as in doctoral schools according to the Bologna-scheme in the European Higher Education Area, which is managed by institutions qualified by the European University Charter (EUC) – typically universities and research institutions. EUC-Institutions currently offer various modules dealing with topics that are relevant for building sustainable materials usage streams. They include:

- Carbohydrate chemistry
- Polysaccharide chemistry
- Biomass chemistry and technology
- Biorefinery
- Bioorganic chemistry
- Biochemistry and biological basics
- Environmental and ecological basics
- Cellulose, wood, and paper technology
- Analytics and characterisation of carbon-based materials
- Spectrum and utilisation of renewable materials
- Waste and emission management
- Sustainability
- Circular economy

The current programmes are focused on technological aspects of engineering and natural sciences. Education in material circularity, life cycle and techno-economic analyses is not systematically embedded in programmes Europe-wide, although these themes are increasingly being found in the academic repertoire.

3.2 What is needed for accelerating upskilling of professionals for a sustainable future?

The EUC-institutions are the main actors in educating Europe, together with the national and European education authorities. Research communities such as EPNOE are at the interface of research and education and have an important role in contributing to the work of upskilling professionals for a sustainable Europe. The aim must be to provide upskilling that can be used for training European citizens and to increase the competitiveness and attractiveness of Europe in sustainable use of resources.

3.3 Stakeholders of upskilling

To be upskilled:

- Students and post-graduates in universities
- Academic staff in universities and research institutes
- Industrial scientists, technicians, and operation managers
- General public
- Entrepreneurs

Contacts for the development of the upskilling infrastructure:

- Local curricula development and maintenance teams
- Steering committees and HR-managers in economy and industry
- Policy makers
- Non-governmental organisations

Dissemination pathways can include emails, webpage-based blog and forums, and commercially operating social media such as LinkedIn, X, and YouTube.

4. Instruments of upskilling

4.1 Upskilling

Upskilling needs to integrate science, engineering, and framework skills. The framework skills include the currently less prevalent but crucial skills: techno-economic analyses, sustainability, circularity, economics, data handling, digitalisation and entrepreneurship, as well as value creation and dissemination (*Figure 1*).

Upskilling must connect academia and industry. **The upskilling backbone should be in the courses that are already being delivered to degree students in Europe, the short courses and schools that are already being offered to doctoral students, and new schools that will cover the skills gap areas. The framework skill training could be facilitated by connecting to educators skilled in framework skills and embedding concepts and material to existing courses iteratively.**

The vision is to compile a holistic education concept that can be rapidly incorporated into existing education infrastructure. Upskilling of professionals already in working life – technicians, managers, and plant operators – is driven by extending access to upskilling to these stakeholders. Upskilling is an opportunity to offer the expertise to decision-makers to facilitate policy work. Internships and practical trainings are useful tools to extend training.

With regard to the skills areas that are underrepresented in current education: techno-economic analyses, sustainability, circularity, economics, data handling, digitalisation and entrepreneurship, value creation and dissemination, efforts must be made across Europe to establish **modules that can be adapted to the existing structures or used autonomously**. It will be of central importance to maintain and continue the work on continuously identifying needs and gaps in skills of professionals.

Virtual activities are important for Europe-wide activities. We must provide activities that connect to the student pool studying subjects in sustainable and renewable materials science and engineering. Existing virtual platforms and online education (such as webinars) may be used as a complement to cover entry-level knowledge for junior researchers and entrants to academic and industrial sectors as well as comprehensive knowhow to facility the community to deepen knowledge, research, and innovation. There are also global opportunities in using digital tools, such as a virtual laboratory that combines material preparation, analysis, and calculations of economic and environmental impact. Use of simulations would reduce the need for training for trial-and-error type of problem-solving. Software for virtual laboratory already exists, but development and resources of European solutions and the means to progress into combining technical tasks with framework tasks should form part of future European programmes. Overview of upskilling activities is shown in Figure 2.

4.2 Industry

It is essential to include industrial commercial actors in upskilling to facilitate, for example, matching of internships with interns, to support scenario-management actions, especially in connection with the framework topics. This is also essential in order to facilitate an iterative loop to determine gaps between skills of the graduates and skills needed in professional life. As an outcome, combined education activities with industries must cover different value chains.

<table>
<tr><th colspan="2">ACADEMIC</th><th>NON-ACADEMIC
Society, economy, industry</th></tr>
<tr><td colspan="3">Actions</td></tr>
<tr><td>• Catalogue of relevant study programmes (BSc, MSc, Doc), intensive / short courses and schools
• Mobility (students, staff)
• Maintaining virtual platforms</td><td>• Inventory of skilled teachers
• Embedding framework skills in existing courses
• Identifying skills needs and gaps</td><td>• Internships / practical trainings
• Industry / academic projects
• Upskilling of industry and economy, scientists and operators</td></tr>
<tr><td colspan="3">Target groups</td></tr>
<tr><td colspan="2">• Students & academic staff
• Local curricula management
• Local international relations offices</td><td>• Industry scientists & operators
• Economy scientists & operators
• Professionals</td></tr>
<tr><td colspan="3">Instruments</td></tr>
<tr><td>• Credit modules
• Schools, intensive courses
• Exchange programmes
• Framework teaching modules
• Surveys for skills gap identification</td><td colspan="2">• Schools, intensive programmes
• Internships
• Junior networks
• Webinars
• Virtual platforms</td></tr>
</table>

Figure 2. Overview of academic and non-academic upskilling activities that are needed for training professionals for sustainable future.

4.3 Certified recognition

The upskilling activities need a **certified recognition**, that is, to award a certification that enables a course to be included in the degree programme curricula. The challenge is to overcome the differentiating procedures of the EUC-Institutions in order to award that recognition. Institutions such as EPNOE can be facilitators in evaluating the training units with respect to content (the expertise to be achieved) and the workload (ECTS), and they could prepare a recommendation for the EUC-institutions that manage the degree certificates.

4.4 Evaluation and benchmarking of skills and monitoring of skills gaps

Skills that are considered essential in professional life are ever-evolving and means of monitoring are needed to keep up to date on the topical needs. We propose instruments such as a yearly survey of industrial and other stakeholders. Such evaluation and benchmarking can help to rationalise the state of the art of education in Europe and communicate results to various audiences, including decision-makers, students, parents, employers, and the general public. Databases of degree graduates and their positions in the job market (subject to compliance with general data protection regulations) may be used to iteratively identify the needs of industry and academia for skills and to provide a feedback loop for development of education curricula. Establishing predictive and automated tools could enable to develop European education. **It is crucial to be able to identify the gaps iteratively to ensure that the right activities can be established in good time.**

5. Vision

5.1 Vision 2030

The vision by 2030 is that European education will utilise the range of available types of learning and teaching mobility programmes, strengthening cooperation between education and research institutions and companies in the sustainable materials field and supporting the mobility of students and employees. Instruments are being used to support green and digital mobility, including blending online and physical exchanges, and to encourage balanced mobility. Training in framework skills will increasingly form part of degree programmes. Open access of education together with virtual sources of information will be used to remove obstacles and barriers to all types of learning and teaching mobility, including issues related to access to knowledge and geographical restrictions.

Specifically, by 2030:

- Upskilling unites academia, industry and the general public
- The sustainable and renewable materials community in Europe has access to training in framework skills

5.2 Vision 2040

The vision by 2040 is that the material use will have shifted towards intentional consumption because of increasing awareness of material life cycles and via techno-socio-economic national and global guidance. This shift will have been largely facilitated by education efforts in sustainable and renewable materials, such as polysaccharides, and framework skills that comprise skills in material circularity, life cycle and techno-economic analyses.

Bachelor, master, and doctoral education in Europe 2040 will deal with sourcing materials from nature and from waste streams, materials manufacturing and uses. The benchmark is know-how on producing materials with targeted quality matched to the purpose of use and its life cycle. The focus is on quantifying the social, economic and environmental impact and constructing sustainable production chain. These will also continuously form part of curricula in all degree programmes.

The technical competences of students at bachelor and master level will have the increased benefit of digitalisation, for example, a virtual laboratory that combines material preparation, analysis, and calculations of social, economic and environmental impact. The teaching in bachelor's and master's degree programmes will utilise virtual means and simulations to minimise training for trial-and-error type of problem-solving.

The students will be enrolled in home universities and participate in European upskilling. Integration of materials and natural science and technology with fields of economics, design, sustainability, management, entrepreneurship, and data handling will facilitate expert educators in their availability and their topics will feature regularly in course curricula. European mobility initiatives and virtual **mobility will allow access to documented training modules.**

The iterative tools will be used for identifying skills gaps and consequent intentional education of professionals who operate in academia and industry. The professionals participating in educational activities will be further enabled to match their expertise with study programmes, thus forming an industrial stakeholder network. Skills education will promote gender and geographical equality, inclusion, as well as sustainability in the long term.

Specifically, by 2040: Degree programmes and training will provide professionals to Europe who are skilled in renewable and sustainable material science and engineering. The skills horizon will attract experts and excellence to Europe and facilitate the resilience of European industry and economy.

6. Connecting framework skills to research in EPNOE

EPNOE Research Committee has identified four focused research areas: Chemistry & Biology, Materials Science & Engineering, Food & Nutrition, and Biomedical (see EPNOE Research Roadmap 2040). Upskilling needs to intertwine with these research themes and to have the flexibility to adapt to changes in research and technology. For example, in EPNOE, research and upskilling form a matrix that allows iteration of education when research item inventory changes (Figure 3). The system is flexible to incorporate topics beyond the engineering core topics and pledges openness and accessibility. Education upskilling will evolve to support the need for research skills and their evolution.

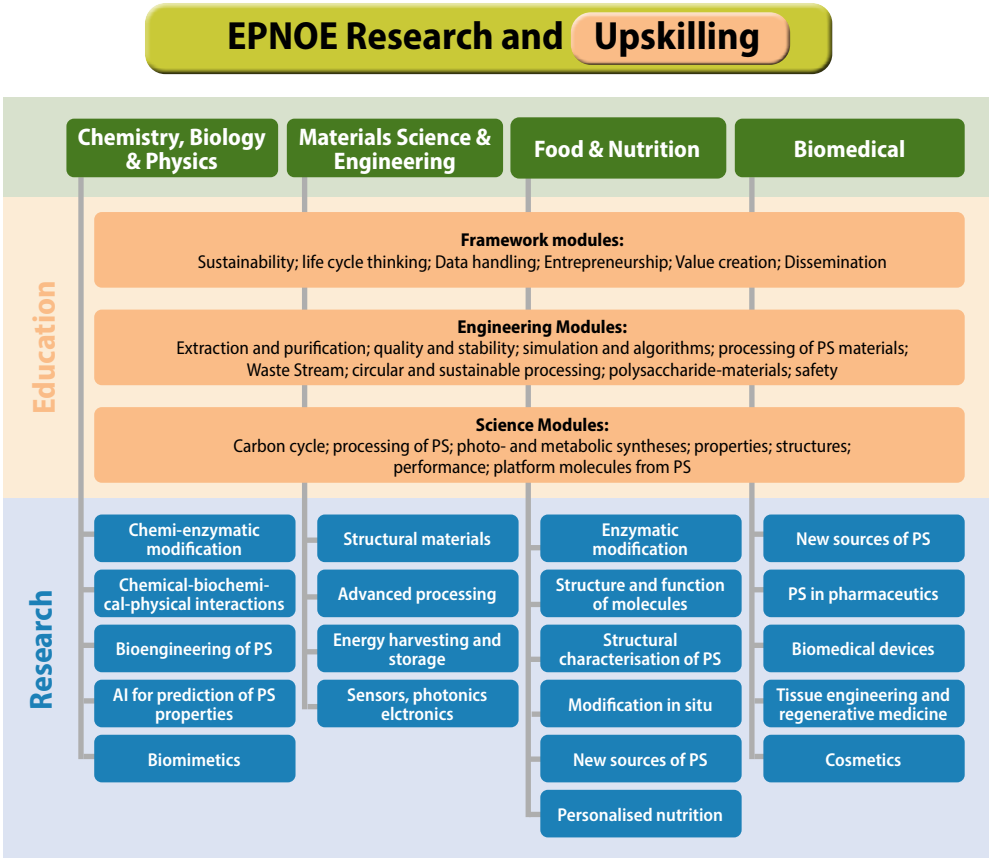

Figure 3. EPNOE Research and upskilling matrix. PS stands for polysaccharides.

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