Version 1

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DBE Scheme

ЦЕНТЪР ЗА РАЗВИТИЕ НА ЧОВЕШКИТЕ РЕСУРСИ

DIGI OMICA

Co-funded by the European Union

ERASMUS+ PROGRAMME

KEY ACTION 2: COOPERATION FOR INNOVATION AND THE EXCHANGE OF GOOD PRACTICES

KA220-HED - COOPERATION PARTNERSHIPS IN HIGHER EDUCATION

Cooperation Partnership for Digital Higher Education in Integrated Omics for Environmental Sustainability

DigiOmica

DIGITAL-BASED EDUCATION SCHEME

WP3 DigiOmica collaborative learning in integrated omics for environmental sustainability

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1. Introduction

DigiOmica Digital-Based Education (DBE) scheme is an instrument that organizes and delivers the innovative educational curriculum **'Integrated Environmental Omics'** grounded on the EQF/NQF/ECTS strategic system for arrangement and performance of a Higher Education process for competencies gaining and assessment.

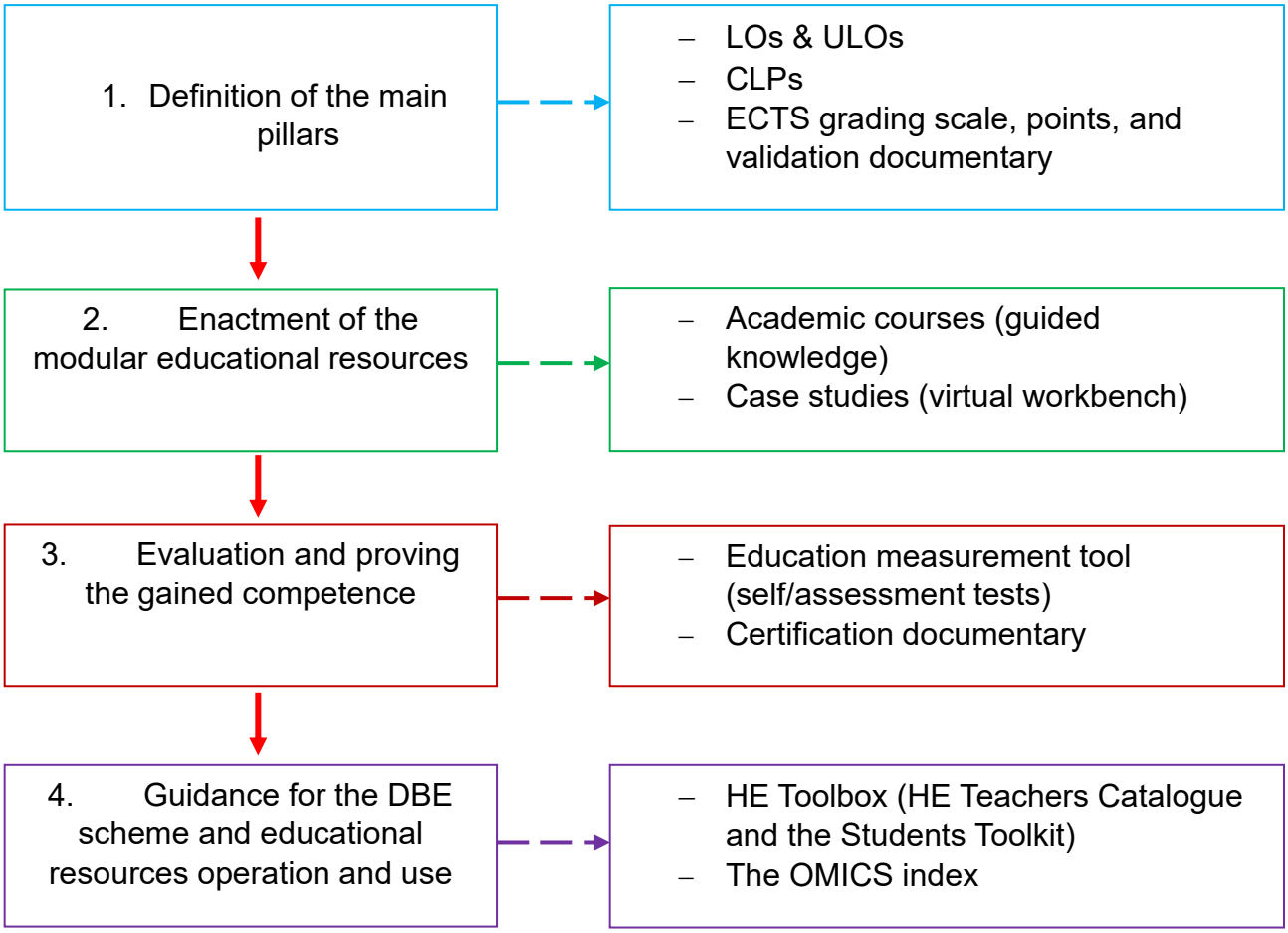
The DBE scheme is structured on the DigiOmica digital platform as an ICT-based technical framework that enhances the learning process. The platform hosts the digital hub **'OMICS e-Learning'** that operates according to the DBE scheme principles and exploits collaborative learning tools for communication, presentation, and assessment of the learning process and its results.

The DBE scheme concept is grounded on the acquisition of knowledge, skills, and autonomy/responsibility towards qualification upgrading. The OMICS e-Learning interrelates in content and methodology the specialized facilities

- **Educational resources** - the academic courses (guided knowledge) and the case studies (virtual workbench);
- **Education measurement tool** for performance of (self)assessment tests to evaluate and prove trainees' achievements;
- **HE Toolbox:** the HE Teachers Catalogue and the Students Toolkit.
- **OMICS index**: the guidance methods and components for arrangement of DigiOmica education process.

They are structured along the steps presented in Fig. 1.

Figure 1. DBE scheme structuring and implementation.



2. Definition and logical interrelation of the DBE scheme main pillars

2.1 Learning Outcomes/Units of Learning Outcomes

The **Learning Outcomes (LOs)** are defined as statements of what a learner is expected to know, understand and be able to do after successful completion of a learning process. The LOs are formulated in terms of knowledge, skills, autonomy/responsibility that can be assessed and validated towards competence

acquisition. The ability to apply LOs adequately in a defined context (education, work, personal or professional development) is defined as a Competence.

In the context of EQF:

- *Knowledge* is described as theoretical and/or factual. It covers the cognitive aspects of the competence;
- *Skills* are described as cognitive (involving the use of logical, intuitive and creative thinking) and practical (involving manual dexterity and the use of methods, materials, tools and instruments). They cover the functional aspects of the competence;
- *Responsibility & autonomy* are described as the ability of the learner to apply knowledge and skills autonomously and with responsibility. They cover the interpersonal attributes: social or organisational skills, and ethical values.

The expected LOs to be acquired upon completion of the education process are formulated and presented in Table 1, below.

Table 1. Expected Learning Outcomes gained upon completion of DigiOmica curriculum "Integrated environmental omics"

Module	Expected Learning Outcomes
Module 1: Genomics: environmental DNA and sampling	– Define eDNA as a tool for monitoring species, populations and communities at molecular level – Explain the application areas of eDNA of microbial origin and macro-organisms in different habitats and time frames – Recognize and apply eDNA sampling protocols for monitoring species distribution – Explain the technical challenges and drawbacks of eDNA sampling and data

	interpretation – Understand the eDNA applications potential
Module 2: Transcriptomics: addressing ecological niches	– Describe the principles of transcriptomics / landscape transcriptomics – Apply Landscape transcriptomics approaches in ecology, evolution, and conservation – Define the main categories of Landscape transcriptomics studies of wild systems in natural environments – Explain the approaches for collection, analysis, and explanation of transcriptomics data from natural environments – Understand the gene expression as a time-based and tissue specific process
Module 3: Advanced environmental proteomics	– Describe the principles of proteomics / environmental proteomics – Apply proteomics studies for assessment of protein diversity of ecosystems and communities – Define the main categories of environmental proteomics studies – Explain the application of environmental proteomics for metabolic engineering, microbial ecology surveys and environmental stress tolerance

	assessment – Specify the challenges, frontiers, and perspective of environmental proteomics
Module 4: Metabolomics: study microorganisms' response to environmental stressors	– Describe the principles of metabolomics / environmental metabolomics – Metabolomics studies to assess metabolites and diversity of ecosystems and communities – Define the major categories of environmental metabolomics research – Explanation of the application of metabolomics of the environment for metabolic engineering, microbial ecology and environmental research, stress – Defining the challenges, limits and perspective of ecological metabolomics
Module 5: Integrated omics in ecotoxicology	– Have general information about the science of ecotoxicology integrated with omics technologies – Integrate the data from omic technologies to assess the molecular responses of organisms to environmental toxicants – Explain how ecotoxicology uses omic technology to assess biomarkers of exposure, impacts, and susceptibility in organisms. – Learn the usage areas of omics technologies in aquatic and terrestrial

	ecosystems – Learns the usage areas of omics technologies in the field of human health
Module 6: Environmental database and bioinformatics	– Describe the principles and key aspects of environmental bioinformatics and its methods and software tools – Use different environmental databases that cover all aspects of human impact on the environment. – Define the major categories of environmental science – Explain the application of environmental bioinformatics – Define the challenges, limits and perspective of environmental bioinformatics
Module 7: Microbial gene transcripts in environmental samples	– Present the core of environmental mRNA (environmental transcriptomics) – Explain the technical difficulties of working with mRNA – Know and apply the basic steps in the protocol for analysis of partial environmental transcriptomes – Understand the major promising applications of environmental mRNA approach in microbial ecology – Apply the good practices in the state of art in single-cell transcriptomics and single-

	cell RNA-sequencing
Module 8: Genomics approach to develop soil biomarkers	– Present the metagenomics as a bioindicator tool for soil health evaluation – Use soil metagenomics for association of specific members to the microbial communities with transformations that certain soils are experiencing – Understand the guided metagenomics (metabarcoding) principles and its advantages and disadvantages – Uprise the shotgun metagenomics technique to understand taxonomic composition and functional potential of soil microorganism communities – Use metagenomics approach in approximations of “OneHealth” and EcoGenomics
Module 9: Omics in aquatic toxicology	– Gain knowledge of how pollutants interact with aquatic organisms at the molecular level through genomics, transcriptomics, proteomics, and metabolomics, elucidating the pathways and processes affected by toxicants. – Identify of biomarkers and characterize molecular biomarkers indicative of exposure to aquatic pollutants, enabling more sensitive and reliable monitoring of environmental contamination and early detection of potential risks to aquatic

	ecosystems. – Integrate of omics data into risk assessment frameworks, allowing for a more comprehensive evaluation of the potential impacts of pollutants on aquatic organisms and ecosystems, and informing evidence-based regulatory decisions. – Apply of omics in aquatic toxicology with designing and conducting omics-based experiments to investigate the effects of pollutants on aquatic organisms, including the selection of appropriate omics techniques, sample preparation, data analysis, and interpretation. – Understand the principles and applications of omics techniques in interdisciplinary research approach with case studies to develop innovative strategies for the protection and conservation of aquatic ecosystems.
Module 10: Air pollution genomics	– Describe how the genome-wide association studies can improve our understanding of the adverse effects of air pollutants – Understand the links between air pollutant exposure and the epigenome – Present the principles of ‘candidate gene’ and the ‘genome-wide’ (‘hypothesis-independent’) approaches as tools for

	assessment of the biological response to air pollutants exposure – Examine the causative role for the epigenome in the adverse effects of environmental exposures, using air pollution as a model – Know the essence of the approach for use of GWAS to measure controlled air pollutants exposures in healthy individuals
Module 11: Omics techniques for biotechnological applications	– Describe the role of a holistic multiomics approach for bioremediation and environmental protection. – Describe: Potential of multiOmics techniques and approaches for biotechnological applications in an environmental context – A multimix solution for developing biotechnology to reduce oil pollution and mitigate environmental damage – Define the main perspectives and challenges in the application of Omics techniques for biotechnological applications in an environmental context.

The **Units of Learning Outcomes (ULOs)** comprise progressively accumulated LOs for achieving/upgrading a qualification, designed to be completed (assessed) independently.

The DigiOmica ULOs are formulated to organize the modular education content, as presented in Table 2.

Table 2. Structured Units of Learning Outcomes.

Unit of Learning Outcomes	Composition
ULO 1	Module 1 Genomics: environmental DNA and sampling Module 8 Genomics approach to develop soil biomarkers
ULO 2	Module 1 Genomics: environmental DNA and sampling Module 9 Omics in aquatic toxicology
ULO 3	Module 1 Genomics: environmental DNA and sampling Module 10 Air pollution genomics
ULO 4	Module 1 Genomics: environmental DNA and sampling Module 11 Omics techniques for biotechnological applications
ULO 5	Module 2 Transcriptomics: addressing ecological niches Module 6 Environmental database and bioinformatics
ULO 6	Module 3 Advanced environmental proteomics Module 6 Environmental database and bioinformatics
ULO 7	Module 4 Metabolomics: study microorganisms' response to environmental stressors Module 6 Environmental database and bioinformatics
ULO 8	Module 5: Integrated omics in ecotoxicology Module 6 Environmental database and bioinformatics
ULO 9	Module 3 Advanced environmental proteomics Module 7 Microbial gene transcripts in environmental samples
ULO 10	Module 6 Environmental database and bioinformatics Module 11 Omics in aquatic toxicology

2.2 Customized Learning Pathways

The **Customized Learning Pathways (CLPs)** represent individual learning objects that are structured from the collection of DigiOmica learning resources (Modules). Each learning object operates as an independent and self-contained building block that can be paired with the other building blocks.

The CLPs are designed in a way to fit DigiOmica target groups and their needs to gain new and upgrade available specific competences within the integrated environmental omics area. They are formulated and launched as personal educational routes assigned to particular end-users' profile and matching EQF reference levels 6, 7, and 8. The CLPs composition is presented in Table 3 and Fig. 2, and their matching to DigiOmica target groups is outlined in Table 4 and Fig. 2.

The CLPs are:

- *Flexible* – trainees learn where and when they choose to fit in with jobs and personal commitments;
- *All-inclusive* – trainees have online/offline access to all high-quality materials they need to study;
- *Supportive* – the educational resources are supported by guidelines for efficient teaching/studying process performance;
- *Social* – trainees make a virtual study network.

Table 3. Composition of DigiOmica Customized Learning pathways.

Customized Learning Pathways	Composition
CLP 1: Environmental genomics and transcriptomics - terrestrial habitats	ULO 1 + ULO 5 Module 1 Genomics: environmental DNA and sampling Module 2 Transcriptomics: addressing ecological niches Module 6 Environmental database and bioinformatics Module 8 Genomics approach to develop soil biomarkers
CLP 2: Environmental genomics and proteomics - water habitats	ULO 2 + ULO 6 Module 1 Genomics: environmental DNA and sampling Module 3 Advanced environmental proteomics Module 6 Environmental database and bioinformatics Module 9 Omics in aquatic toxicology
CLP 3: Environmental genomics and metabolomics - air pollution	ULO 3 + ULO 7 Module 1 Genomics: environmental DNA and sampling Module 4 Metabolomics: study microorganisms' response to environmental stressors Module 6 Environmental database and bioinformatics Module 10 Air pollution genomics
CLP 4: Integrated environmental omics – ecotoxicology applications	ULO 4 + ULO 8 Module 1 Genomics: environmental DNA and sampling Module 5: Integrated omics in ecotoxicology Module 6 Environmental database and bioinformatics Module 11 Omics techniques for biotechnological applications
CLP :5 Integrated environmental omics in	ULO 1 + ULO 8 Module 1 Genomics: environmental DNA and sampling

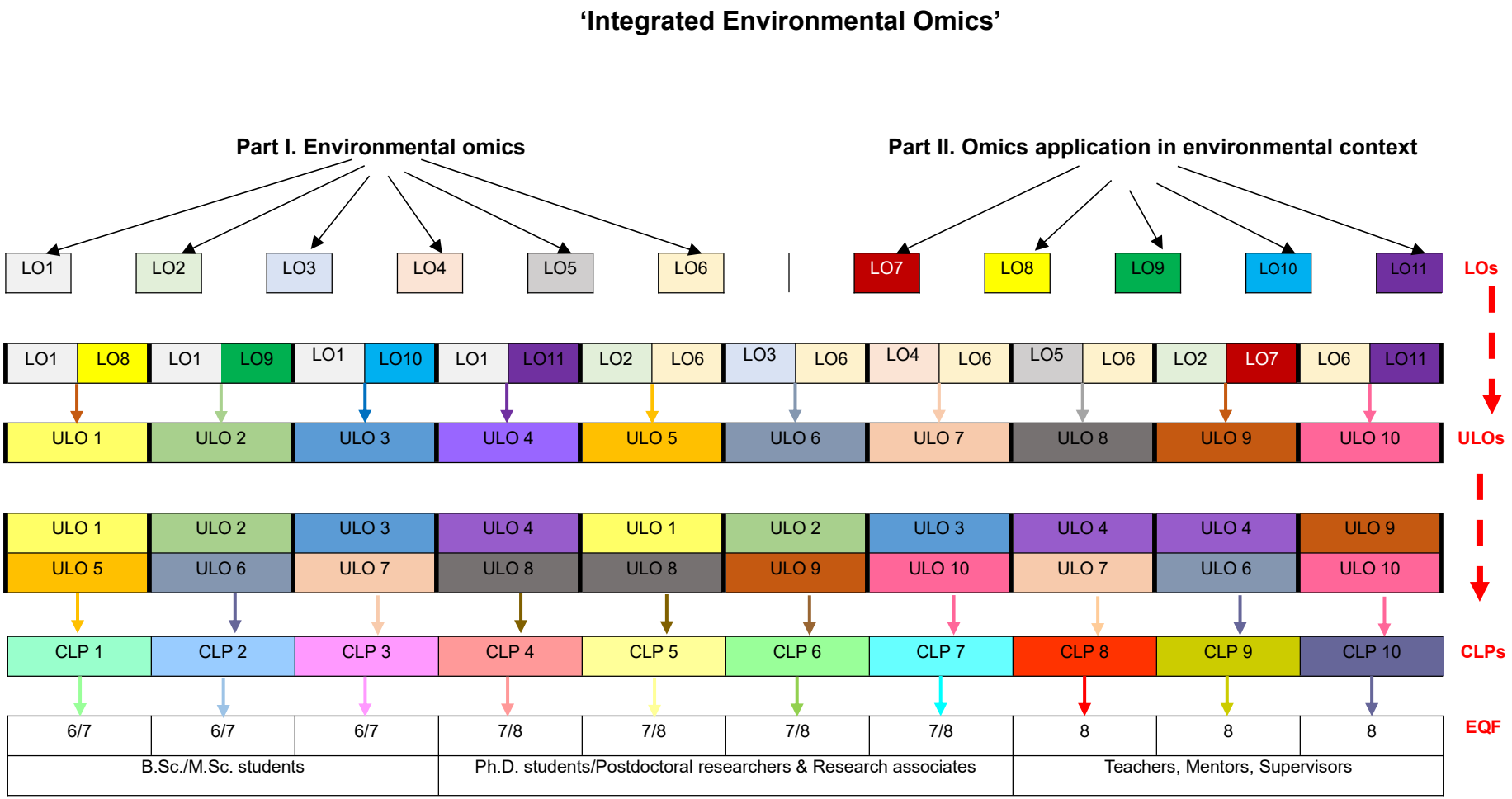
soil biomarkers establishment	Module 5: Integrated omics in ecotoxicology Module 6 Environmental database and bioinformatics Module 8 Genomics approach to develop soil biomarkers
CLP 6: Integrated environmental omics in aquatic toxicology	ULO 2 + ULO 9 Module 1 Genomics: environmental DNA and sampling Module 2 Transcriptomics: addressing ecological niches Module 7 Microbial gene transcripts in environmental samples Module 9 Omics in aquatic toxicology
CLP 7: Integrated environmental omics for air pollution assessment	ULO 3 + ULO 10 Module 1 Genomics: environmental DNA and sampling Module 6 Environmental database and bioinformatics Module 10 Air pollution genomics Module 11 Omics techniques for biotechnological applications
CLP 8: Integrated environmental omics – environmental stressors response	ULO 4 + ULO 7 Module 1 Genomics: environmental DNA and sampling Module 4 Metabolomics: study microorganisms' response to environmental stressors Module 6 Environmental database and bioinformatics Module 11 Omics techniques for biotechnological applications
CLP 9: Integrated environmental omics – biotechnology applications	ULO 4 + ULO 6 Module 1 Genomics: environmental DNA and sampling Module 3 Advanced environmental proteomics Module 6 Environmental database and bioinformatics Module 11 Omics techniques for biotechnological applications

CLP 10: Integrated environmental omics – ecological samples and niches monitoring	ULO 9 + ULO 10 Module 2 Transcriptomics: addressing ecological niches Module 6 Environmental database and bioinformatics Module 7 Microbial gene transcripts in environmental samples Module 11 Omics techniques for biotechnological applications

Table 4. DigiOmica Customized Learning Pathways matching the target groups/EQF reference levels.

CLPs	Target group / EQF Reference Level
CLP 1	Under(graduates): B.Sc./M.Sc. students EQF 6/7
CLP 2	Under(graduates): B.Sc./M.Sc. students EQF 6/7
CLP 3	Under(graduates): B.Sc./M.Sc. students EQF 6/7
CLP 4	Postgraduates: Ph.D. students/Postdoctoral researchers & Research associates EQF 7/8
CLP 5	Postgraduates: Ph.D. students/Postdoctoral researchers & Research associates EQF 7/8
CLP 6	Postgraduates: Ph.D. students/Postdoctoral researchers & Research associates EQF 7/8
CLP 7	Postgraduates: Ph.D. students/Postdoctoral researchers & Research associates EQF 7/8
CLP 8	Academic professionals (Teachers, Mentors, Supervisors) EQF 8
CLP 9	Academic professionals (Teachers, Mentors, Supervisors) EQF 8
CLP 10	Academic professionals (Teachers, Mentors, Supervisors) EQF 8

Figure 2. Structuring of DigiOmica Customized Learning Pathways assigned to defined target groups and EQF reference level



2.3 ECTS grading scale, points, and validation documentary

The competence acquired by the trainees completed defined CLP is assessed applying the principles of **ECTS**. **ECTS credit points** as a numerical representation of the overall weight of LOs in a qualification and of the relative weight of ULOs in relation to the qualification are awarded upon completion of a self(assessment) test (see section 3 below).

The DigiOmica grading scale is depicted in Table 5.

Table 5. DigiOmica ECTS grading scale.

Module	ECTS credit points
Part I. Environmental omics	
Module 1: Genomics: environmental DNA and sampling	3
Module 2: Transcriptomics: addressing ecological niches	3
Module 3: Advanced environmental proteomics	3
Module 4: Metabolomics: study microorganisms' response to environmental stressors	3
Module 5: Integrated omics in ecotoxicology	3
Module 6: Environmental database and bioinformatics	3
Part II. Omics application in environmental context	
Module 7: Microbial gene transcripts in environmental samples	3
Module 8: Genomics approach to develop soil biomarkers	3
Module 9: Omics in aquatic toxicology	3
Module 10: Air pollution genomics	3
Module 11: Omics techniques for biotechnological applications	3

3. Enactment of the integrated environmental omics subject into the DBE scheme

The DBE scheme foresees representation of the modular educational resources - the academic courses (guided knowledge) and the case studies (virtual workbench) at the OMICS e-Learning section of DigiOmica digital platform.

The educational resources are elaborated in accordance to a predefined by the partners template (see “Instructions for authors” at https://digi-omica.eu/consortium-area/) to facilitate their uniform integration in the OMICS e-Learning section of the digital portal.

4. Evaluation and proving the gained competence

The DBE scheme provides (self)assessment options for weighting gained knowledge/skills against qualification upgrading. The performance of (self)assessment tests’ function is implemented in the OMICS e-Learning section of the digital portal as a specific education measurement tool that serves to evaluate and evidence trainees’ achievements.

The (self)assessment option is developed in compliance with the requirements shown in Table 6.

Table 6. Requirements for structuring and operation of the (self)assessment panel.

Type of questions:	Multiple Choice and True/False Questions
Number of questions / Module:	10 questions; 5 MCQ and 5 T/FQ
Total questions pool:	110 questions

Number of questions / CLP:	– 10 questions – Selected at random from a sub-pool of 40
Results reporting:	– Available detailed results score – Available final report on performed test – E-mail notification about successful test passing and certification document delivery
Number of test attempts:	– 3 attempts/CLP – Upon triple failure – 1 month of restricted access to the test panel

Upon successful completion of a CLP, a certification document is provided to the trainee with the following elements:

- Name of the trainee;
- Name of the body awarding the certificate;
- Title of the CLP attended;
- Credit points awarded;
- Profile of knowledge, skills, autonomy & responsibilities acquired.

5. Guidance for the DBE scheme and educational resources operation and use

The DME scheme foresees support of the trainees' efficient exploitation of the DBE scheme and educational resources through the production of guidance manuals to facilitate the educational process and make it more productive and beneficial for the users. These are the:

- **Catalogue of new teaching, learning, and assessment forms for HE teachers:** a guidance manual comprising contemporary teaching, learning, and assessment forms applicable in HEIs to facilitate education practices.
- **Students Toolkit:** a comprehensive set of guidelines for students that instruct them how to develop study skills and master effective study habits for successful academic accomplishments.
- **OMICS index** - a manual for platform use including guidance methods and components for arrangement of DigiOmica education process.