BioS

DIGITAL SKILLS ON COMPUTATIONAL BIOLOGY FOR HEALTH PROFESSIONALS

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R2.2. BioS modular curricula

WP2: Curricula Design

Responsible Partner: P11 HiDucator

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Executive Summary

The aim of the BioS modular curricula is to define the framework for development of the training modules (1-4) and the case studies on promotion of WBL for the improvement of medical doctor's competences in the field of Bioinformatics for clinical application. The BioS curricula will integrate the latest advancements in the field of bioinformatics/computational biology that can be immediately applied by medical doctors.

The BioS curricula is modular, based on the learning outcomes approach, leading to ECVET credits. It will integrate WBL components through "real work life" case studies and case-based learning, offered both through the BioS VLE and in physical clinical and enterprise context.

The BioS curricula will be comprised by the following four (4) modules: Module 1: Introduction to Bioinformatics, Module 2: Computational Statistics for clinical doctors, Module 3: Commercial personalised genomics services in patient care, and Module 4: Quality Improvement in Healthcare:

Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including Commission services and project reviewers)	
CO	Confidential, only for members of the consortium (including EACEA and Commission services and project reviewers)	

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1. Introduction

It is commonly agreed that personalized medicine, driven by genomic sequencing of individuals, will transform medicine. There is great potential for genome sequencing to enhance patient care through improved diagnostic sensitivity and more precise therapeutic targeting[1]. BioS aims at advancing the digital skills of medical doctors through the design, development and delivery of new modular vocational curricula on Computational Biology, as well as transversal skills, directly responding to skills needs to be identified by existing research evidence. Further, the programme aims to advance the skills of these professionals to interpret the results of the modern biomedicine in their practice. Its ultimate purpose is to provide medical doctors with knowledge, skills and competences which will allow them to tackle effectively concurrent challenges in EU healthcare systems, services, and policies, in benefit of the health of EU citizens.
This project is carried out within the EQAVET (European Quality strategies in Vocational Education and training) and EQF/ECVET (European qualifications framework/European Credit system for Vocational Education and Training) frameworks in order to ensure both quality and better transferability of the project's results. In the context of EQF, learning outcomes are defined as pertaining to knowledge, skills, and competence. The BioS curricula are mainly aimed at EQF level 5, so the learning outcomes will be targeted reference to the descriptors of level 5 as given in Table 1 below[2].

Table 1: Learning outcome descriptors at European Qualifications Framework level 5. Adapted from "*Recommendation of the European Parliament and of the Council of 23 April 2008 on the establishment of the European Qualifications Framework for lifelong learning*"[3]

EQF Level	Knowledge	Skills	Competence
	Knowledge is described as theoretical and/or factual.	Skills are described as cognitive and practical.	Competence is described in terms of responsibility and autonomy.
Level 5 Relevant learning outcomes	Comprehensive, specialised, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge.	A comprehensive range of cognitive and practical skills required to develop creative solutions to abstract problems.	Exercise management and supervision in contexts of work or study activities where there is unpredictable change; review and develop performance of self and others.

[1] Ashley, EA. Towards precision medicine, Nature Reviews Genetics, 17, 507–522 (2016)
[2] BioS Methodological Guide, 2018
[3] Recommendation of the European Parliament and of the Council of 23 April 2008 on the establishment of the European Qualifications Framework for lifelong learning: Official Journal of the European Union. 2008/C 111/01

2. Curricula for the four Core Modules

The BioS project aims at the production of four core modules, namely:

- Module 1: Introduction to Bioinformatics
- Module 2: Computational Statistics for clinical doctors
- Module 3: Commercial personalized genomics services in patient care
- Module 4: Quality Improvement in Healthcare

The curriculum for each module is presented below.

2.1 Module 1: Introduction to Bioinformatics

Description

This module provides basic knowledge of how molecular data connects to modern biomedicine in order to give an understanding of background of genomic/personalized medicine. The course introduces the student to genomic data, DNA and protein sequence data and protein structures, major biological databases and teaches basic methods for their analyses.

Expected learning outcomes

See Table 2 for the detailed description of Learning Outcomes.
After completing this module, the student will be able to:

- retrieve information and data regarding specific genes and proteins which could be chosen as candidate genes for a disease, e.g. functional information and sequence variant information
- perform analyses and comparisons to identify essential and non-essential parts in a gene or a protein, e.g. multiple sequence alignments using publicly available, web-based tools
- understand how applying such skills can lead to quick and cost-effective diagnoses of diseases and disorders with a genetic component

Training content

- Biological databases, with main focus on DNA and protein sequences and on human genome data
- Comparison and alignment of sequences, similarity-based searches in databases
- Genome browsers
- Micro-RNAs and their targets

- Metabolic pathway data as a resource for evaluating relevance of disease candidate genes
- Sources of gene expression data
- Case studies

Module duration: 4 weeks, expected workload 7 to 10 hours per week

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Table 2: Module 1: Learning Outcomes of Introduction to Bioinformatics

EQF LEVEL	UNIT OF LEARNING OUTCOME	HOURS	CREDITS
5	INTRODUCTION TO BIOINFORMATICS	40	4

KEY TECHNICAL OUTCOME	KNOWLEDGE	SKILLS	COMPETENCE
1. Retrieve information and data regarding specific genes and proteins which could be chosen as candidate genes for a disease.	The Learner knows and understands: ● The relevance of biological sequences for health and diseases ● Basic terms related to sequence handling ● Medical relevance of sequence annotation	The Learner is able to: ● Gather information on selected genes and proteins using tools such as BLAST, UniProt, and PDB ● Compare biological sequences through multiple sequence alignment ● Identify the active site of an HIV Serine protease (or of any other structurally characterized enzyme)	The Learner: ● Is aware of the power of modern high-throughput sequencing methods and applies sequencing data to improve diagnostics of diseases with a suspected genetic component ● Uses up-to-date knowledge from databases of genes and proteins to support their estimates of the significance of genes suggested as contributors in a genetic disease ● When needed, considers protein structure in the interpretation of variant data
	PERFORMANCE CRITERIA		
	● Uses sequence and annotation files to access up-to-date, in-depth knowledge of medically relevant genes (with the help of the demonstrated Internet databases and tools) ● Uses the discovered information to make more informed clinical decisions based on genetic variant data		

KEY TECHNICAL OUTCOME	KNOWLEDGE	SKILLS	COMPETENCE
2. Visualize genomic features and perform simple analysis on them using Internet based tools.	The Learner knows and understands: ● List of available databases and other Internet resources ● Functional Genome Annotation and Metabolic Pathways	The Learner is able to: ● Visualize genomic data in a genome browser ● Find information of known genome variants associated to desired genes ● Find and visualize functional genome annotations and metabolic pathway information	The Learner: ● Uses genomic tools routinely to get a quick, integrated view of data related to any gene as necessary ● Gains a knowledge-based, data driven view of every new disease-related gene they encounter
	PERFORMANCE CRITERIA		
	● Uses the demonstrated tools to visualize annotations of their candidate gene lists; ● Uses Internet resources including Genome Browsers and KEGG; ● Interprets gene information critically in the light of up-to-date information.		

OUTPUTS

- **More confidence in data from modern-day high-throughput sequencing;**
- **Making more use of such data in clinical decision-making;**
- **More informed interpretation of personal genome data;**
- **Quicker and more relevant diagnoses of diseases with an assumed genetic component.**

2.2 Module 2: Computational Statistics for clinical doctors

Description

This module will provide a practical introduction to analysis of biological and biomedical Big data, in order to develop a critical understanding of the reliability of analysis results. Clinical doctors will learn to appreciate how the R statistical environment can be applied to biological data analysis in a cost-efficient manner.

Learning objectives/outcomes

See Table 3 for the detailed description of Learning Outcomes.

- Understanding of descriptive statistics, elements of probability, hypothesis testing, nonparametric methods, correlation analysis, and linear regression
- Understanding of how to choose appropriate statistical tests and how to assess statistical significance
- Understanding of how to visualize data and carry out statistical testing
- Understanding of R, a powerful programming language for statistical computing and graphics
- Understanding selected kinds of analyses of biomedical data that a professional can carry out easily using e.g. the BioConductor package of R for the analysis of sequencing data from a patient

Training content

- Basic statistical techniques, including: descriptive statistics, elements of probability, hypothesis testing, nonparametric methods, correlation analysis, and linear regression
- How to choose appropriate statistical tests and how to assess statistical significance
- Biological data analysis with R: Demonstrations of how data can be visualized and tested within the R language environment, e.g. how variants can be identified from sequencing data
- Case study

Module duration: 4 weeks, expected workload 7 to 10 hours per week

Table 3: Module 2: Learning Outcomes of Computational Statistics for Clinical Doctors

EQF LEVEL	UNIT OF LEARNING OUTCOME	HOURS	CREDITS
5	COMPUTATIONAL STATISTICS FOR CLINICAL DOCTORS	40	4

KEY TECHNICAL OUTCOME	KNOWLEDGE	SKILLS	COMPETENCE
1. Understanding key elements of modern statistical analysis.	The Learner knows and understands: ● Descriptive statistics, elements of probability, hypothesis testing, nonparametric methods, correlation analysis, and linear regression ● Elements of statistical reports ● Elements of the visualization of statistical data	The Learner is able to: ● Choose appropriate statistical tests ● Perform simple statistical analyses using software tools ● Assess statistical significance ● Evaluate if appropriate statistical test is used in an analysis ● Interpret statistical graphs	The Learner: ● Pays attention to statistical values associated with reports of sequencing data and its analysis reports; ● Weights their decision-making in the light of the statistical uncertainty of each finding.
	PERFORMANCE CRITERIA		
	● Operates with elements of statistical analysis to interpret analysis results; ● Reads analysis reports and research articles with a statistically critical approach.		

KEY TECHNICAL OUTCOME	KNOWLEDGE	SKILLS	COMPETENCE
2. Using free software for statistical analysis of data from case studies.	The Learner knows and understands: ● The role of R software in statistical analysis ● CRAN and Bioconductor	The Learner is able to: ● Install R, RStudio, and selected related statistical software packages and use them ● Organize and perform a data analysis project of biomedical data ● Create and handle graphs from an analysis	The Learner: ● Is aware of the power and limitations of statistical analyses of biomedical data, especially of high-throughput sequencing data ● Requests custom-made analyses from professionals, knowing that efficient, simple, and free tools exist enabling almost any analysis they can think of, in an easy and cost-efficient way
	PERFORMANCE CRITERIA		
	● Makes more use of statistical parameters in decision-making, especially related to analysis of sequencing data from a patient ● Designs ideas for custom analyses if needed in complex situations		

OUTPUTS
• **More efficient use of biomedical research results;** ● **Incorporating sequencing data and the use of associated statistical data more efficiently into diagnostic practice.**

2.3 Module 3: Commercial personalized genomics services in patient care

Description

The purpose of this module is to provide medical doctors the necessary knowledge and skills to interpret results from commercial personalized genomics services, like 23andMe, deCODE, Gene by Gene, etc. This module facilitates integrating these services into their patient care activities.

Learning objectives/outcomes

See Table 4 for the detailed description of Learning Outcomes.
After completing this module, the student should be able to:

- Explain single nucleotide polymorphisms (SNPs) and different types of SNPs
- Describe some example roles of SNP's in disease development
- Describe the basic principles of variant effect prediction for genetic variants in protein-coding genes and in micro-RNA genes
- Use reports in patient care from commercial personal genomics services
- Interpret SNP-related increased and decreased risks in selected diseases
- Interpret commercial reports and translate them to actions in appropriate health care segments

Training content

- SNPs and their role in health and disease
- Disease risk related statistics and their interpretation
- Overview of reports from the following services: 23andMe, deCODE, Gene by Gene
- Translating example reports to non-disease phenotypes with selected example traits, e.g. bitter taste perception
- Translating example reports to disease risks with selected example diseases, e.g. asthma
- Translating example reports to drug response traits with relevant examples, e.g. Warfarin sensitivity
- Case study

Module duration: 4 weeks, expected workload 7 to 10 hours per week

Table 4: Module 3: Learning Outcomes of Commercial personalized genomics services in patient care

EQF LEVEL	UNIT OF LEARNING OUTCOME	HOURS	CREDITS
5	COMMERCIAL PERSONALIZED GENOMICS SERVICES IN PATIENT CARE	40	4

KEY TECHNICAL OUTCOME	KNOWLEDGE	SKILLS	COMPETENCE
1. Understanding the nature and role of single nucleotide polymorphisms (SNPs) and other genetic variants.	The Learner knows and understands: ● Different levels of genetic and genomic variants; ● Variant terminology; ● Theoretical aspects of human genetics related to genomic variations; ● Variant analyses within populations; ● Diagnostic tools used for variant detection and analysis.	The Learner is able to: ● Access and study genetic variant data from on-line databases; ● Read reports of patient sequence variant analyses.	The Learner: ● Considers carefully the contribution of genetic variants for a given patient case
	PERFORMANCE CRITERIA		
	● Uses this learning for more informed reading of reports from genomic sequencing services ● Uses variant databases for accessing more information on disease gene candidates		

KEY TECHNICAL OUTCOME	KNOWLEDGE	SKILLS	COMPETENCE
2. Using variant analyses	The Learner knows and understands: ● Types of available commercial personalized genomics services and other genetic tests ● Differences between their analysis methodology ● Principles of variant effect predictions	The Learner is able to: ● Select appropriate genetic tests for a given clinical situation ● Interpret reports from different genomics services ● Assess the reliability of information sources used in different genomic services	The Learner: ● Evaluates always if genetic variant analyses are needed and appropriate; ● Uses personal genomic reports to gain a better understanding of patient's health status; ● Applies available research knowledge for personalizing patient treatment and/or preventive measures.
	PERFORMANCE CRITERIA		
	● Uses different genomics services to support clinical work when a genetic component is assumed ● Assesses individual patient status taking into account information from genomic sequencing reports		

OUTPUTS

- **Integration of the available commercial personalized genomics services into patient care practice**
- **More timely and more cost-efficient clinical decisions**
- **Better choices in treatments and in disease prevention**
- **Improved health**

2.4 Module 4: Quality Improvement in Healthcare

Description

This module programme will aim to equip trainees with a range of knowledge and skills, which are relevant and applicable in communications within healthcare contexts. Participants will learn how to build high-performing and engaged healthcare teams, establish and sustain effective clinical relationships, as well as implement strategies and tools to support patient-centered care. Additionally, with patient safety initiatives at the forefront of care, a major goal of this module will be to help health care professionals to develop the background knowledge and skills necessary for the specialty of risk management.

This module is focused especially to the communication, ethics and risks associated with genetic testing and disease risk assessment.

Training content

- Communication and Management in Healthcare
- Risk Management in Healthcare
- Decision making in Healthcare

Module duration: 2 weeks, expected workload 5 to 10 hours per week.

Table 5: Module 4: Learning Outcomes of Quality Improvement in Healthcare

EQF LEVEL	UNIT OF LEARNING OUTCOME	HOURS	CREDITS
5	QUALITY IMPROVEMENT IN HEALTHCARE	10	2

KEY TECHNICAL OUTCOME	KNOWLEDGE	SKILLS	COMPETENCE
More efficient communication of disease risks related to genetic testing	The Learner knows and understands: ● Concepts related to disease risk assessment ● Ethical issues related to genetic testing ● Tools to support communication	The Learner is able to: ● Communicate risk information to patients in understandable and compassionate ways ● Help health professionals make informed decisions of treatment or non-treatment of discovered diseases ● Give genetic counselling	The Learner: ● Identifies and addresses the differences in patients' values, preferences and expressed needs ● Aims at a coaching culture that supports consistent exceptional care and service
	PERFORMANCE CRITERIA		
	● Implements strategies and tools to support patient-centred care; ● Improves the patient experience by better communication.		

OUTPUTS

- **Attracting and engaging customer-focused employees who are passionate about providing the best and most compassionate, yet efficient, care to the patient**
- **Effective clinical relationships**
- **Patient experience framework that better meets and exceeds the patient's need**