

## MAIN OBJECTIVES & EXPECTED RESULTS

**HEALS** (Health and Environment-wide Associations based on Large population Surveys) aims at integrating in an innovative approach a comprehensive array of novel technologies, data analysis and modelling tools that support efficiently exposome studies.

The exposome represents the totality of exposures from conception onwards, simultaneously identifying, characterizing and quantifying the exogenous and endogenous exposures and modifiable risk factors that predispose to and predict diseases throughout a person's life span.

Assessing individual exposure to environmental stressors and predicting health outcomes implies that both environmental exposures and epi/genetic variations are reliably measured simultaneously. For the first time, HEALS will try to reverse the paradigm of "nature versus nurture" and adopt one defined by complex and dynamic interactions between DNA sequence, epigenetic DNA modifications, gene expression and environmental factors that all combine to influence disease phenotypes.

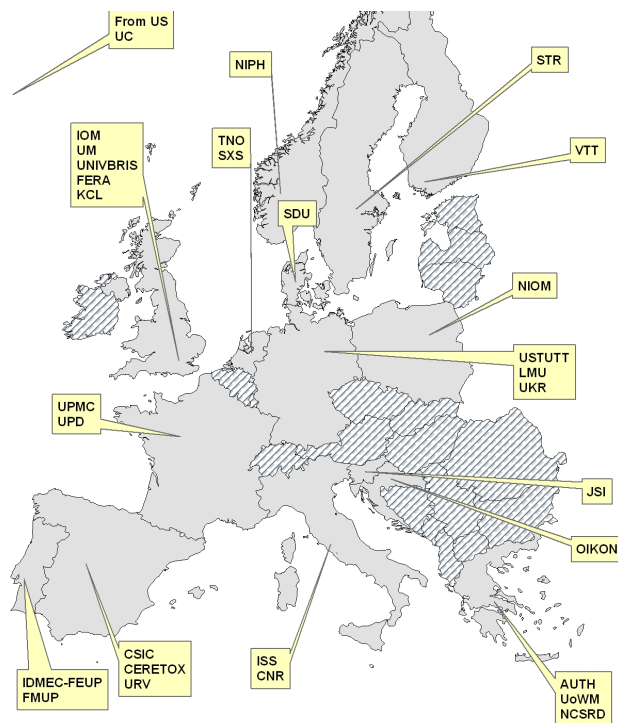
The HEALS approach brings together and organizes environmental, socio-economic, exposure, biomarker and health effect data; in addition, it includes all the procedures and computational sequences necessary for applying advanced bioinformatics coupling thus effective data mining, biological and exposure modelling so as to ensure that environmental exposure-health associations are studied comprehensively.

The final aim of HEALS is the refinement of an integrated methodology and the application of the corresponding analytical and computational tools for performing Environment-Wide Association Studies (EWAS) in support of EU-wide environment and health assessments.

## HEALS PARTNERSHIP

The HEALS consortium consists of 29 partners from 14 European countries and from US.

These 29 partners form a truly multi-disciplinary consortium and cover the wide range of expertise necessary for developing the integrated approach to the exposome, including environmental exposure monitoring and modelling, biological monitoring, -omics genetics and epigenetics, bioinformatics and data-mining, epidemiologists, toxicologists, and software programmers as well as its impact on health. Geographically the participants cover all main regions of Europe.



Such coverage will ensure that the knowledge generated by the project and the tools developed are applicable and disseminated across all main regions of Europe and hence its population centres.



# HEALS

Health and Environment-wide Associations  
based on Large population Surveys

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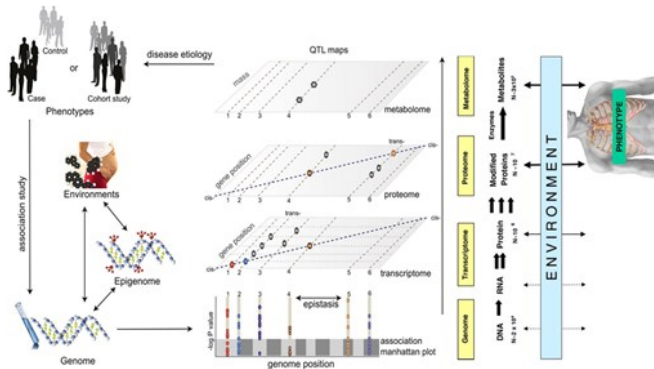
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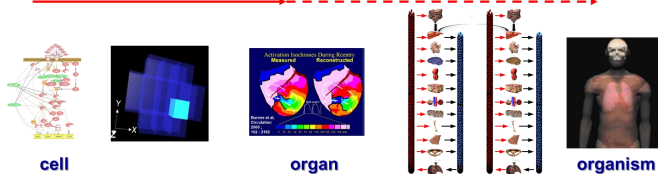
## HEALS EXPOSOME APPROACH

The exposome represents the totality of exposures from conception onwards, simultaneously identifying, characterizing and quantifying the exogenous and endogenous exposures and modifiable risk factors that predispose to and predict diseases throughout a person's life span. Unraveling the exposome implies that both environmental exposures and genetic variation are reliably measured simultaneously.



HEALS brings together a comprehensive array of novel technologies, data analysis and modeling tools that support efficient design and execution of exposome studies.

### "Systems Biology" Approach

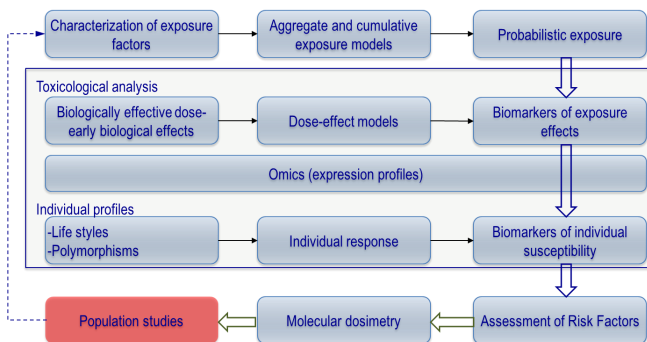


### "Physiome" Approach

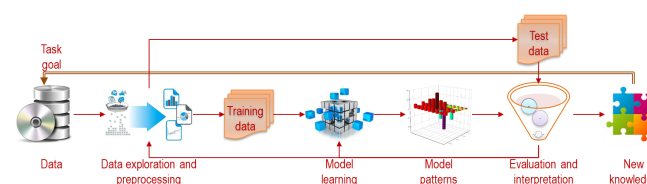
HEALS introduces the integrated approach to health risk assessment. The external exposome will be derived by data and model fusion using algorithms for mining existing environmental monitoring datasets and ubiquitous sensing using geo-localized sensors and mobile phones and the coupling of these data with agent-based models.

## HEALS OMICS & BIOINFORMATICS

HEALS proposes the functional integration of -omics derived data and biochemical biomonitoring to create the internal exposome at the individual level. These data will be exploited using advanced bioinformatics tools for both descriptive and predictive data mining. HEALS will propose a novel bioinformatics strategy focusing on biomarker fusion, and direct coupling of physiology-based biokinetic models to metabolic regulatory networks derived from -omics analyses. In this way, the internal dose of environmental stressors will be coupled to the alterations they bring about to gene expression, protein-protein interactions and metabolic regulation and plausible hypotheses on the respective pathways of toxicity can be established.

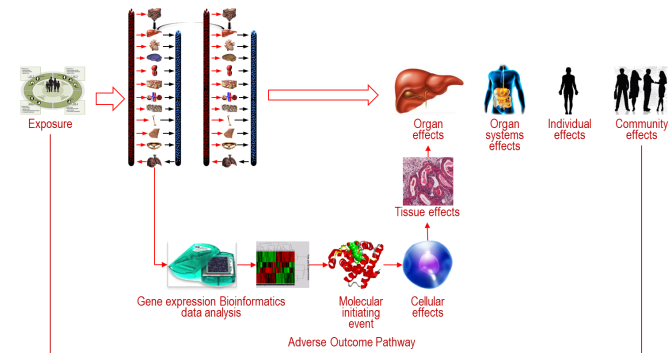


Another key aspect of HEALS is the carving of innovative bioinformatics strategies for biomarker prediction. The bioinformatics tools currently available for biomarker detection and analysis range from statistical approaches to data mining. The latter is the process of discovering valuable information from large amounts of data in the form of associations, patterns, changes, or significant structures.



## HEALS POPULATION STUDIES

The HEALS approach and tools will be put to test through their application in a number of population studies (including twins studies) across different exposure settings tackling key health endpoints of the SCALE initiative and the Parma Declaration for both children and the elderly, with a particular attention towards common health endpoints such as asthma, allergies, obesity, diabetes and neurodevelopmental disorders. The overall population size involved in these studies is up to ca. 335,000 individuals covering different age, gender and socio-economic status groups including ethnic minorities and vulnerable individuals.



Based on the results of these population studies, a pilot exposure and health survey (EXHES) will be organized in 10 EU countries to test the applicability of the HEALS approach. EXHES will combine a longitudinal and a nested case-control phase to allow for better definition of environmental exposures and better characterization of disease and risk phenotypes over the limited duration of the project, whilst setting the foundation for post-project follow-up. The technological and computational integration proposed in HEALS will be tested through EXHES with regard to both technical feasibility and cost-effectiveness. The lessons drawn from the EXHES pilot survey will provide the basis for drafting scientific advice, protocols and, eventually, guidance for the setting up of a European Health and Exposure Survey, paving the way to EU-wide assessments.