Deciphering the genomic code to enable accurate disease diagnosis & cure malfunctions

Genomic disorders are diseases caused by the loss or gain of chromosomal/DNA material: copy number losses (deletion syndromes) and gains (duplication syndromes).

While the pace of advances in genomic science and technology has been rapid, more research is needed before we can fully realize the potential benefits from improved disease treatment and prevention.

One of the crucial challenges surrounding rare disease diagnosis is knowing exactly which of the many potentially functional variants found in a patient's genome is responsible for her/his disease. Integrating genome-wide genetic association data with genomic-scale annotation data has often led to a virtuous cycle of mutual advantage, such as defining the tissues, and sometimes also the specific cell types that are central to the pathogenesis of a specific disease.

New tools & results to better decipher genomic malfunctions

Over the last few years, three European projects, MRG GRAMMAR, BEYONDSEQ and PROSEQO, have working on tackling the challenges that are key to advancing the field.

The focus of the collaborative research marks a significant step towards deciphering the genomic code for a better understanding of genomic malfunctions. This is crucial for coming up with better cures for the malfunctions diagnosed, including genomic and personalised medicine.

The collective portfolio of the results from the three projects highlight novel technologies spanning DNA sequencing, biomarker discovery, genetic/genomic/ cytogenetic diagnostics. Other advances include generating new types of biological datasets for a much deeper understanding of the causes of many diseases.

Tools & Datasets

- Cutting-edge tools for accurate and cost-effective Next Generation Sequencing, protein sequencing, advanced high-throughput DNA sequencing, biomarker discovery and genetic diagnostics.
- Multifunctional platform and iterative improvements of the data analysis from the assessment of instrument performance in SMS, both of nucleic acids and amino acids.
- Toolbox for integrated genetic and epigenetic profiling of single DNA molecules, for readout, extraction and quantification of medically relevant genomic information.
- Reagents, prototype DNA barcoding devices and data analysis software for a range of applications.
- Diagnosis/prognosis tools for hematological malignancies; spinal muscular atrophy and early diagnosis of colorectal and lung cancer.
- Analysis of long individual DNA molecules without PCR-amplification by using emerging optical DNA mapping technologies.
- New biological datasets that systematically explore all possible regulatory landscapes.
- A comprehensive database containing the grammar rules of the regulatory code.

Technologies & Models

- Sequencing technology to enhance optical detection and control the movement of molecules through optical trapping.
- Optical technologies based on new plasmonic device, protein sequencing and single molecule DNA/RNA sequencing.
- Analytical models to reconstruct the exact sequence from the signals recorded & predict enhancer activity in bacteria, yeast and mammalian cells.
- Predictive nucleotide-level model of enhancer function to extract the underlying regulatory principles from data.
- Algorithms to decipher extant natural regulatory code and interpret variations leading to a profoundly deeper understanding of the origins of many diseases.
- Highly engineered systems for molecular translocation / movement control.
- A novel approach for plasmonic enhanced FRET and SERS spectroscopy for the sequencing of proteins, along with new molecular designs for enhanced FRET spectroscopy rulers.

The impact of genomic disease diagnosis & treatment

- Transforming patient treatment toward more effective and personalized medicine approaches.
- Facilitating the development of new tools to characterize heterogeneous molecular ensembles through accurate and fast sequencing.
- Providing a reference in designing and implementing accurate and more controllable synthetic biology devices.
- Deciphering extant natural regulatory code, but also interpreting variations leading to a much deeper understanding of the origins of many diseases.
- Developing a significantly advanced single-molecule DNA/RNA sequencing approach, with breakthroughs in deciphering, and evolving, the regulatory code.
- Exploring the regulatory landscapes thanks to new types of biological datasets.
- Enhancing optical detection and controlling the movement of molecules through optical trapping.
- Allowing close interconnection between different technological and scientific fields: physics, biotechnology, bioinformatics and engineering.
- Developing novel technologies for third-generation sequencing of protein and DNA/RNA.

Who benefits?

Research & Academia

Innovation Platforms and Clusters

Start-ups and SMEs

Large Enterprises: medical and health sciences

Civil Society and Non-Profit Organisations

The EU cluster of research projects with novel & innovative technologies for genomic diagnostics & disease prevention/diagnosis

MRG GRAMMAR

Accelerating the advance of technologies and knowledge related to generating systematic and personal therapeutic solutions through the analysis of an individual's natural genomic variations.

PROSEQO

Paving the way for using novel technologies in a wide range of applications, such as next generation protein sequencing, advanced high-throughput DNA sequencing, biomarker discovery, and genetic diagnostics.

BeyondSeq

Developing a robust toolbox for integrated genetic and epigenetic profiling of single DNA molecules, for readout, extraction and quantification of medically relevant genomic information.

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