

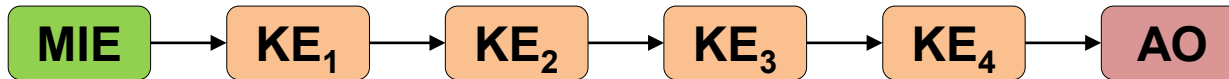


# Adverse Outcome Pathways and Data Integration in Nanosafety

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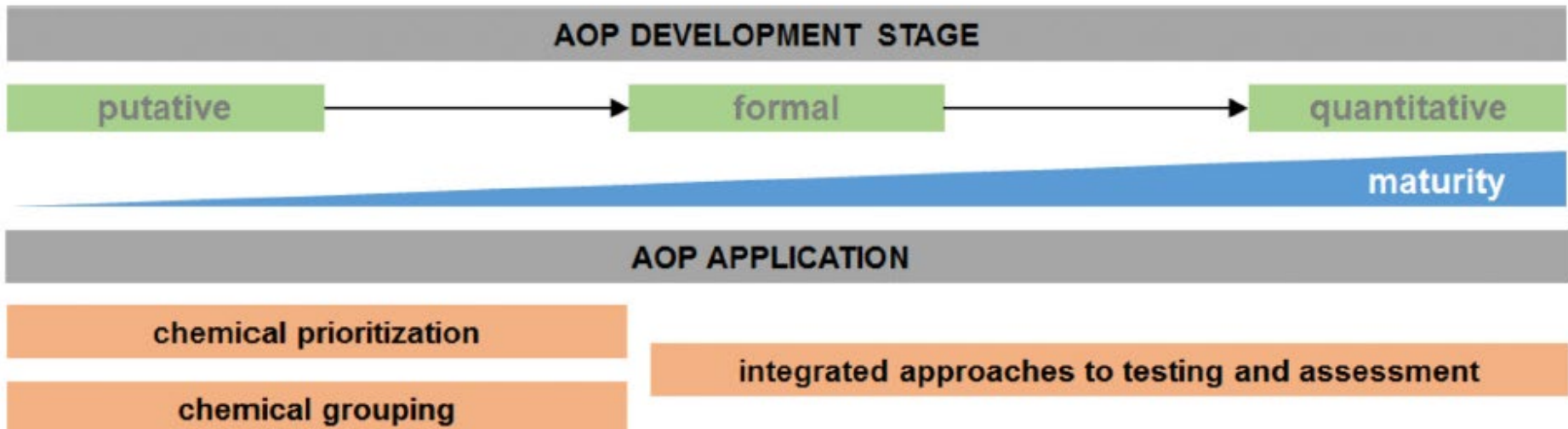
NanoSafety Cluster (NSC) Education Day @ NanoSAFE 2020, 16<sup>th</sup> November

## An Adverse Outcome Pathway is...



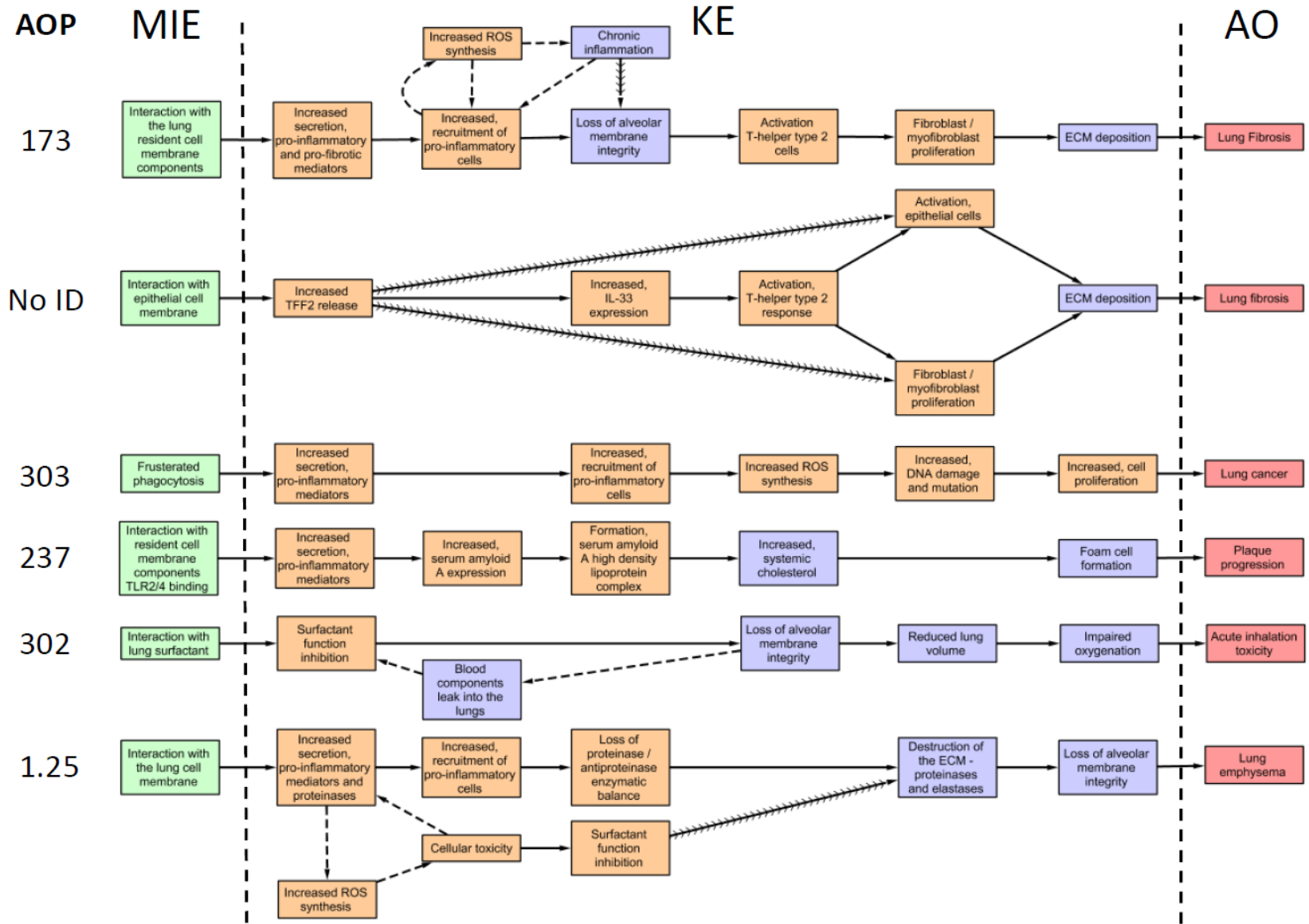
...a conceptual framework that portrays **existing knowledge** concerning **biologically plausible** key events (KE) that **causally** link a molecular initiating event (MIE) to an adverse outcome (AO).

## Data integration serves both AOP development and application to risk assessment



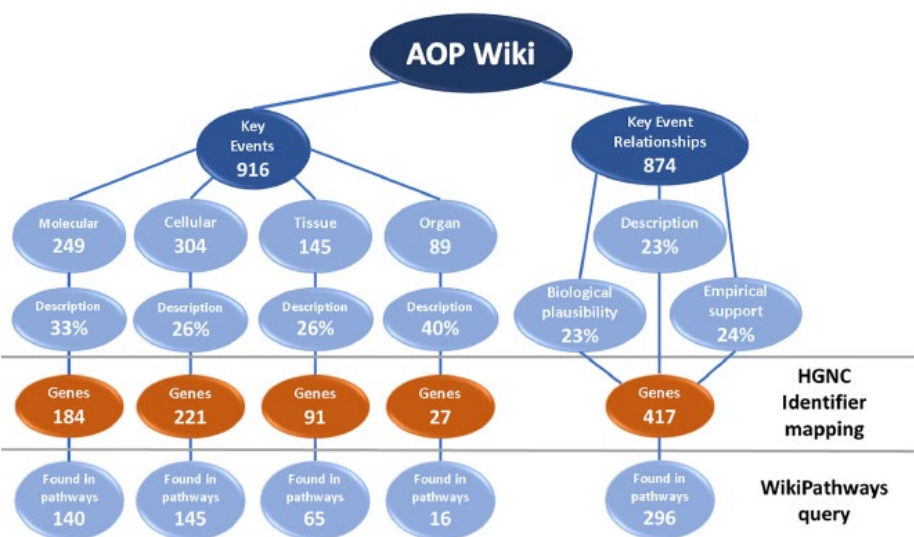
Vinken et al. Arch Toxicol. 2017 November ; 91(11): 3697-3707.

# Nanomaterials are used as model stressors to develop AOPs

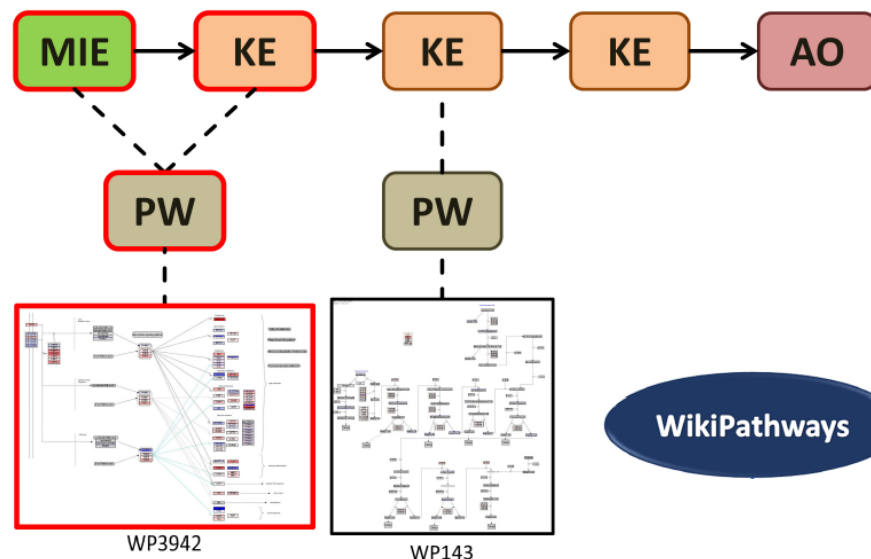


# Linkage with existing life science knowledge supports data integration for AOP development

## Mapping the AOP-Wiki to genes and molecular pathways



## Enriching AOPs with molecular detail and enabling AOP-coupled transcriptomics analyses



Martens M, Verbruggen T, Nymark P, Grafström R, Burgoon LD, Aladjov H, Torres Andón F, Evelo CT, Willighagen EL. **Introducing WikiPathways as a Data-Source to Support Adverse Outcome Pathways for Regulatory Risk Assessment of Chemicals and Nanomaterials.** *Front Genet.* 2018 Dec 21;9:661. <http://doi.org/10.3389/fgene.2018.00661>

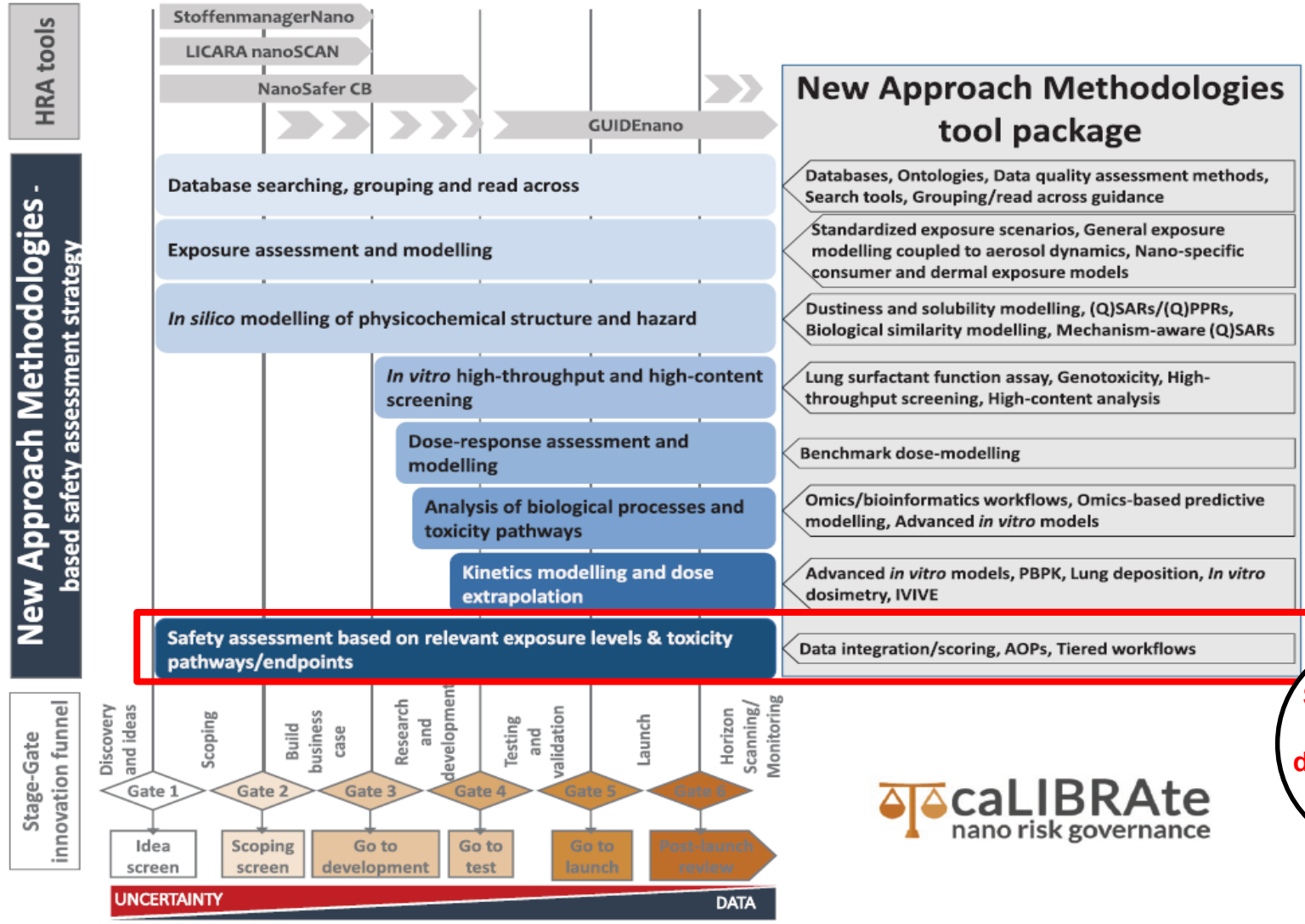
# AOP-linked molecular descriptions support big data-driven hazard characterization

## Data fusion pipeline concept

1. Literature-based disease process descriptions
2. Open source data for disease-related genes
3. Gene-interaction databases
4. Functional schemes based on pathway enrichment analysis
5. Genes/functional schemes linkage to AOP-related key events
- 6. Interactive, bioinformatically useful AOP-linked molecular pathway**

# AOPs support data integration across all stages of risk assessment

– from Safe by Design strategies to regulatory requirements

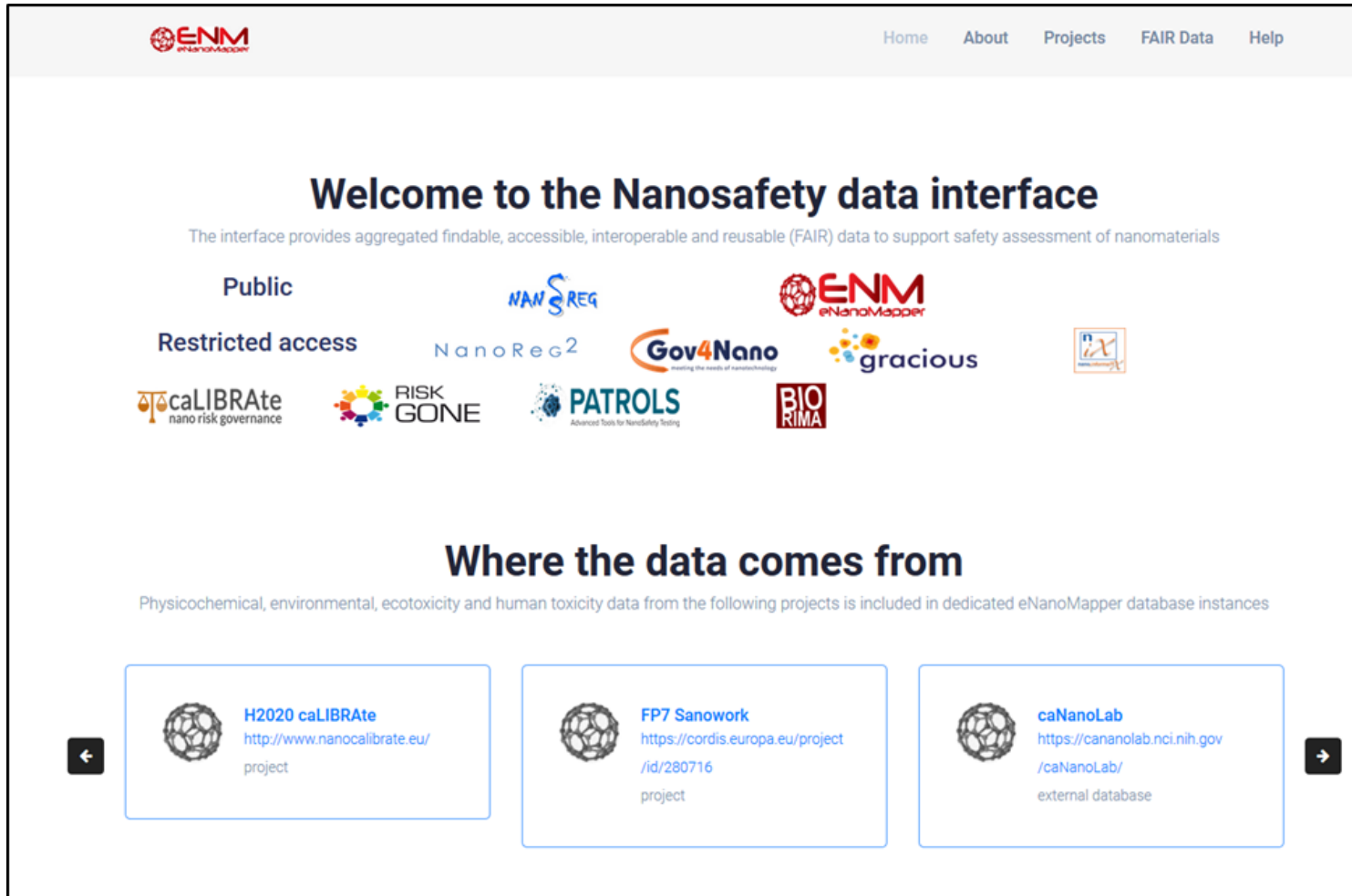


Scaling and scoring of diverse types of data



# FAIR Nanosafety data in support of AOP development and application

[search.data.enanomapper.net/](https://search.data.enanomapper.net/)



The screenshot shows the ENM (eNanoMapper) website interface. At the top, there is a navigation bar with links for Home, About, Projects, FAIR Data, and Help. The main heading is "Welcome to the Nanosafety data interface", followed by a sub-heading: "The interface provides aggregated findable, accessible, interoperable and reusable (FAIR) data to support safety assessment of nanomaterials". Below this, there are two sections: "Public" and "Restricted access". The "Public" section includes logos for NANOREG and ENM. The "Restricted access" section includes logos for NanoReg2, Gov4Nano, gracious, caLIBRAtE, RISK GONE, PATROLS, and BIO RIMA. A second section titled "Where the data comes from" explains that data is included from various projects. Three project boxes are shown, each with a nanosphere icon, a project name, and a URL: H2020 caLIBRAtE (http://www.nanocalibrate.eu/project), FP7 Sanowork (https://cordis.europa.eu/project/id/280716/project), and caNanoLab (https://cananolab.nci.nih.gov/caNanoLab/external\_database).

Findable  
Accessible  
Interoperable  
Reusable

New FAIR Implementation  
Network for Nanosafety



[www.go-fair.org/implementation-networks/overview/advancednano/](https://www.go-fair.org/implementation-networks/overview/advancednano/)

# Acknowledgements

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