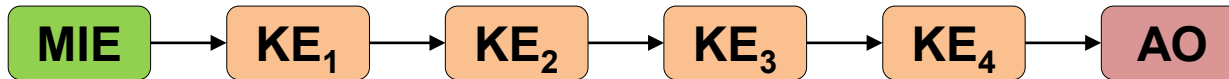# Adverse Outcome Pathways and Data Integration in Nanosafety

Penny Nymark, Assistant Professor
Institute of Environmental Medicine
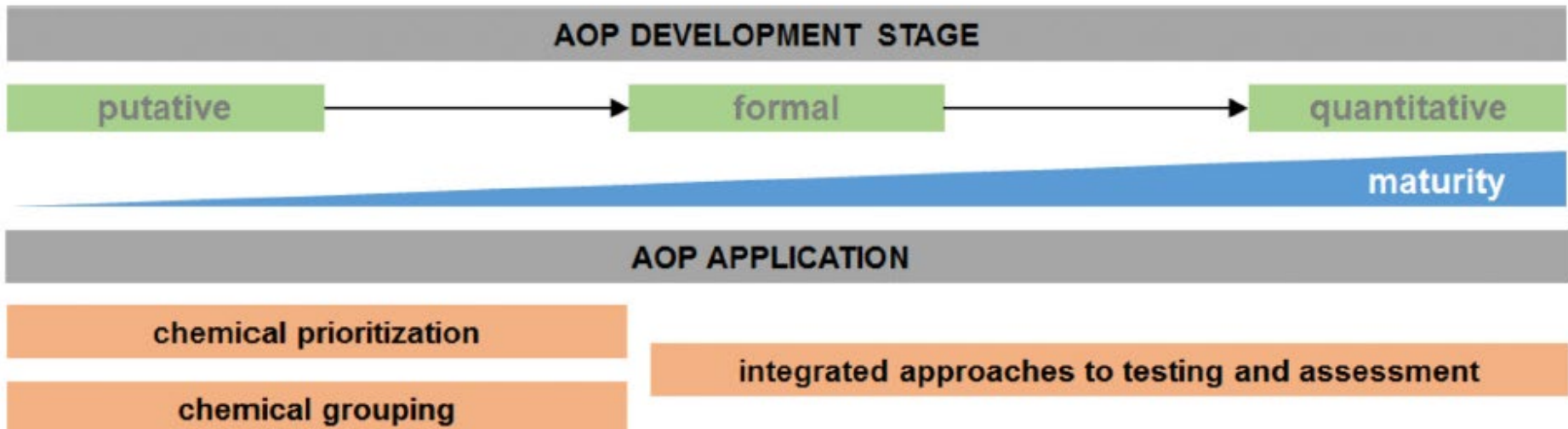**Karolinska Institute, Sweden**

NanoSafety Cluster (NSC) Education Day @ NanoSAFE 2020, 16th November

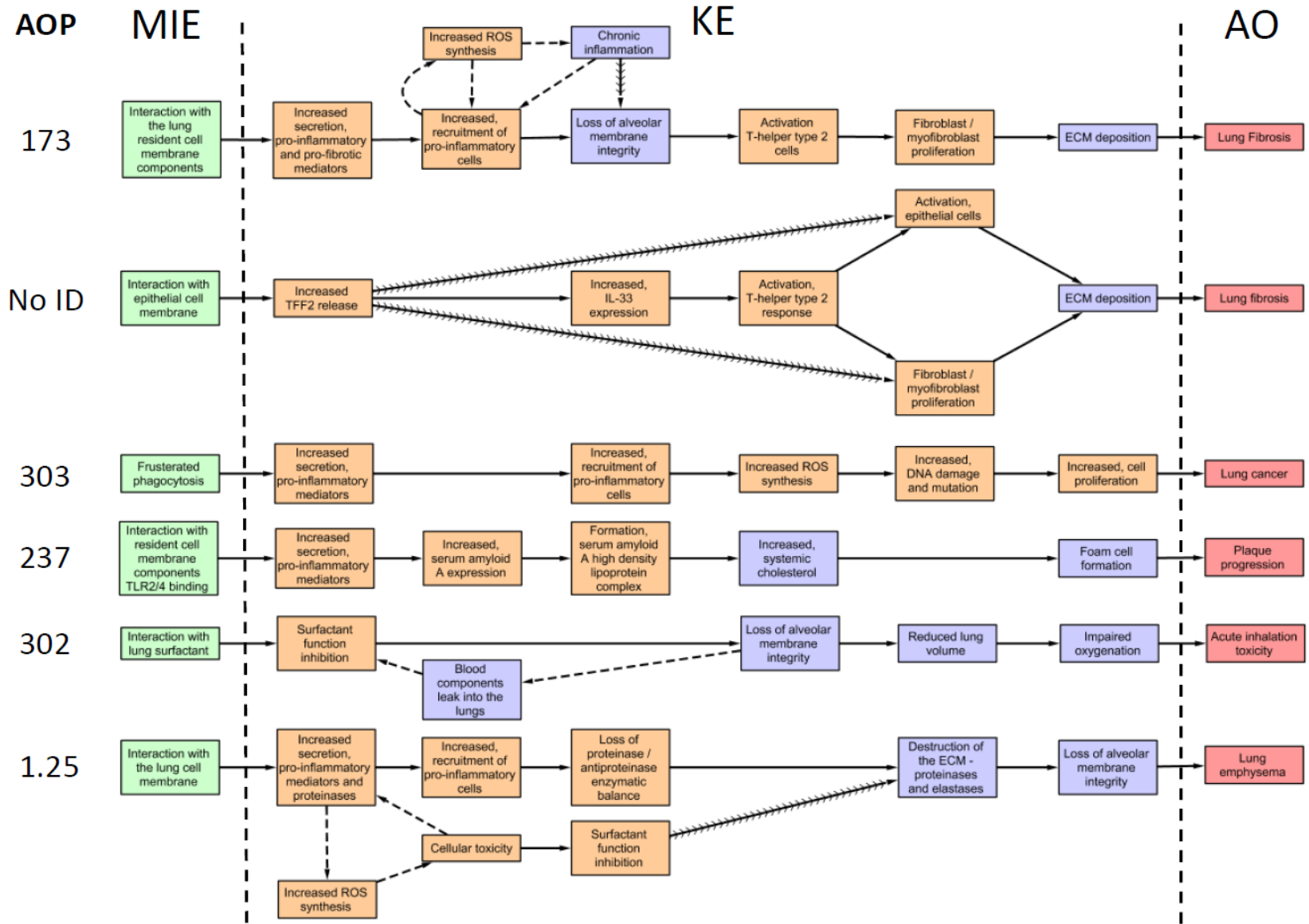# An Adverse Outcome Pathway is…

MIE → KE₁ → KE₂ → KE₃ → KE₄ → AO

…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


AOP DEVELOPMENT STAGE

putative → formal → quantitative

maturity

AOP APPLICATION

chemical prioritization

chemical grouping

integrated approaches to testing and assessment

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

Nanomaterials are used as model stressors to develop AOPs

Halappanavar S, van den Brule S, Nymark P, Gaté L, Seidel C, Valentino S, Zhernovkov V, Danielsen PH, De Vizcaya A, Wolff H, Stoeger T, Boyadziev A, Poulsen SS, Sørli JB and Vogel U. **Adverse Outcome Pathways as a tool for the design of testing strategies to support the safety assessment of emerging advanced materials at the nanoscale.** Part Fibre Toxicol. 2020 May 25;17(1):16. http://doi.org/10.1186/s12989-020-00344-4

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

Mapping the AOP-Wiki to genes and molecular pathways
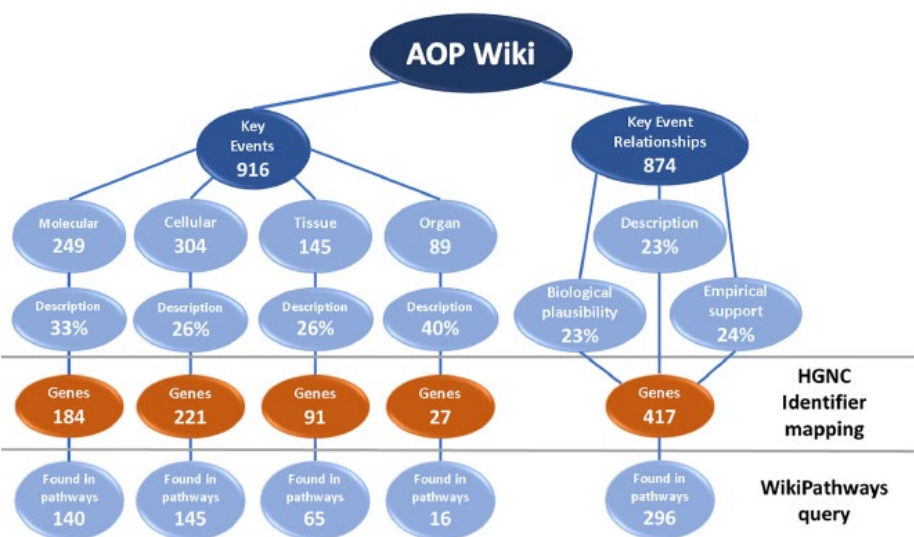
## Enriching AOPs with molecular detail and enabling AOP-coupled transcriptomics analyses
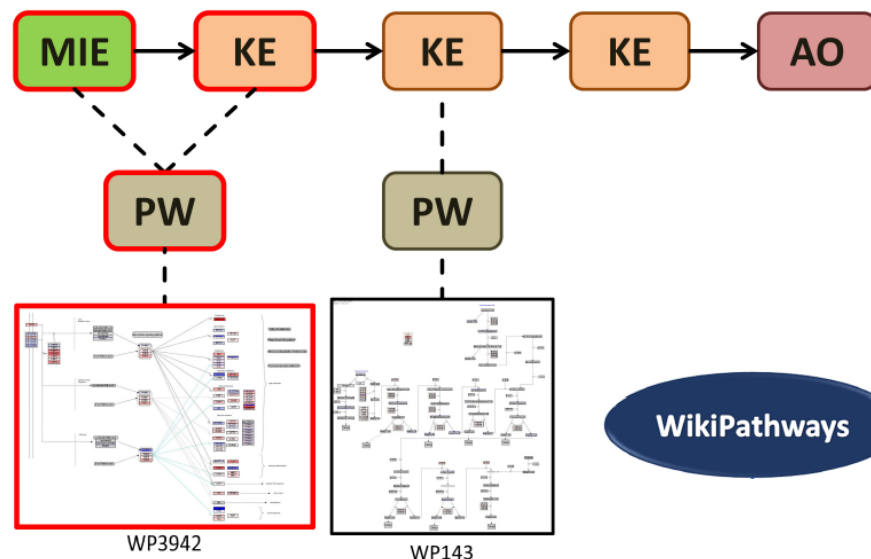
AOP-linked molecular descriptions support big data-driven hazard characterization

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
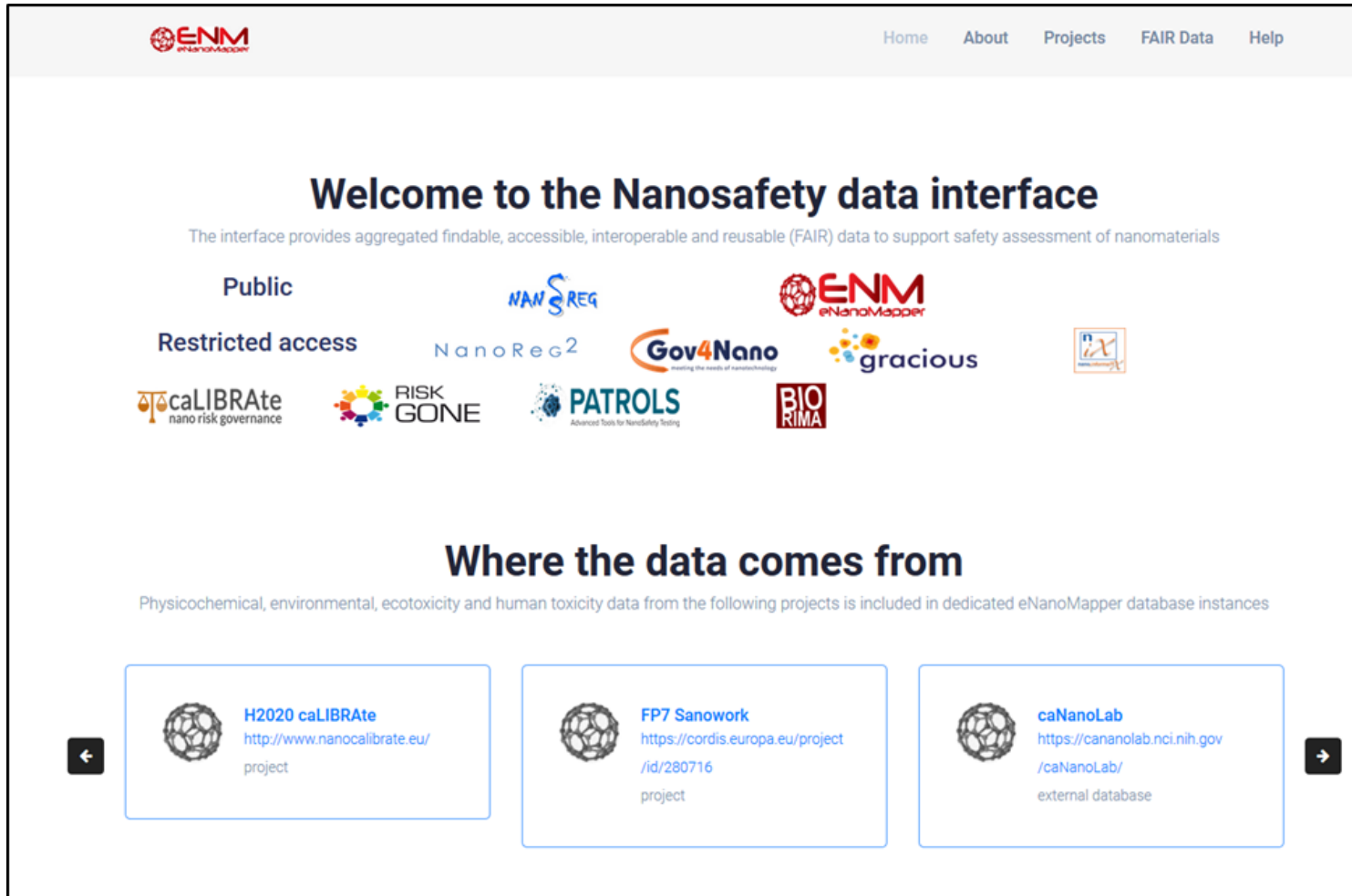## – from Safe by Design strategies to regulatory requirements
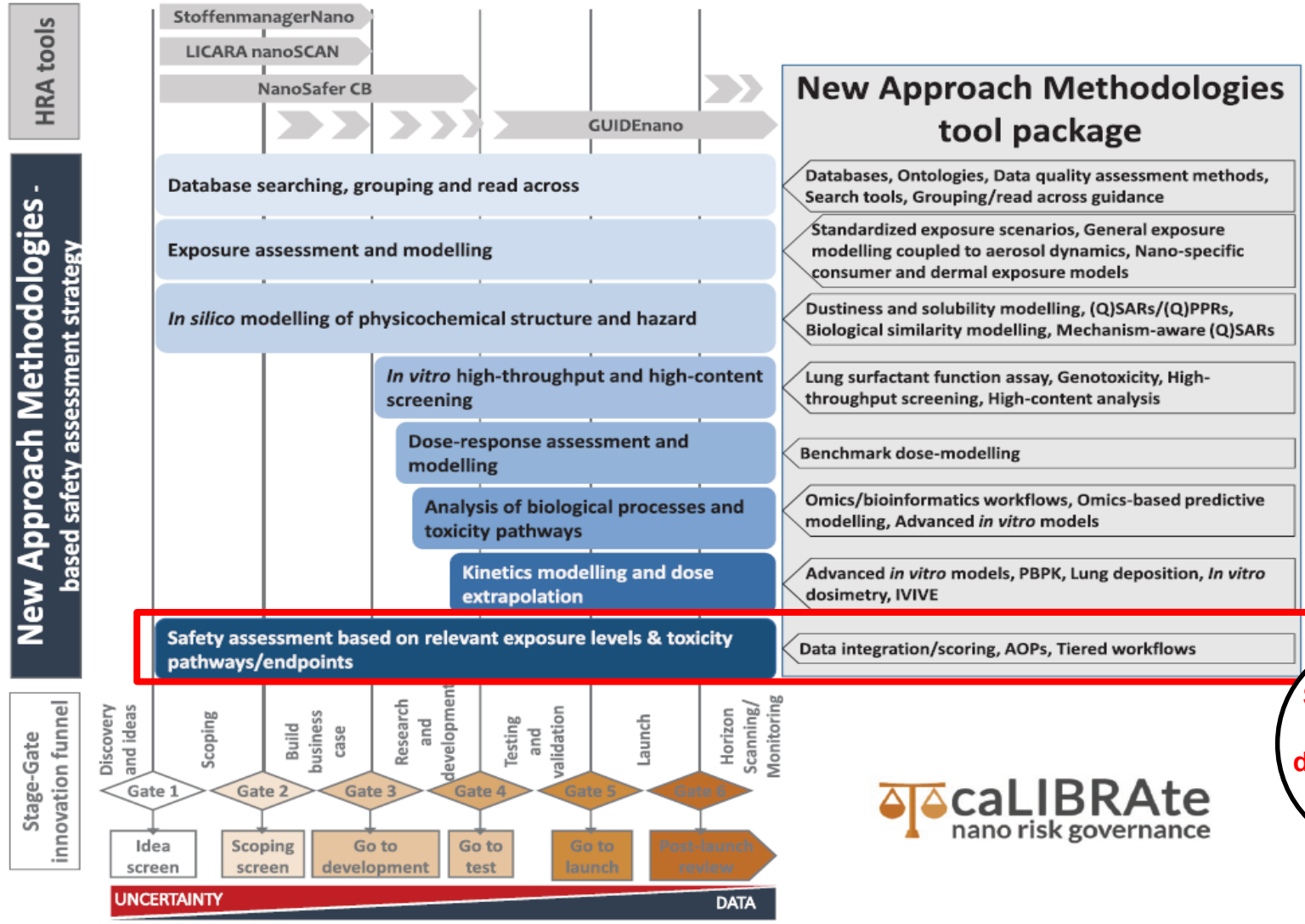
FAIR Nanosafety data
in support of AOP development and application

search.data.enanomapper.net/

Findable
Accessible
Interoperable
Reusable

New FAIR Implementation Network for Nanosafety

www.go-fair.org/implementation-networks/overview/advancednano/

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