Analytical Techniques Used to Measure Exposure: Material Characteristics Related to Consumer Products

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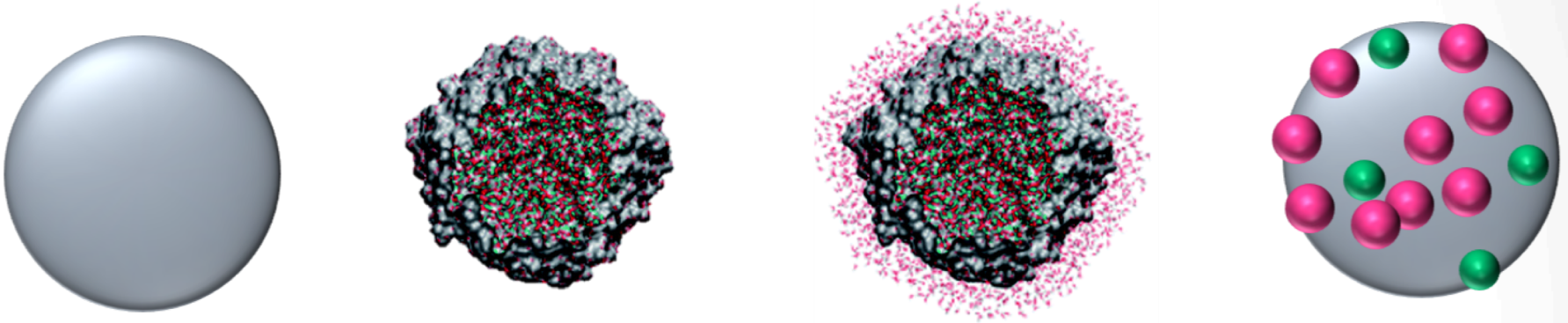
Introductory Remarks

- NEED: To establish the quality metrics suitable for performance and risk assessment
  - Physicochemical characterization can help accomplish this GOAL
- PCC must include, a range of different nanoparticle
  - Including pristine, degraded, metabolized, and complexed systems
- Ultimately, the objective is to consider the entire nano-enabled product life-cycle with respect to its manufacture, use, and eventual fate
- The tools and approaches to address the needs of these products exist

Analytical considerations of pristine, degraded, metabolized, and complexed nanomaterials
…and the way in which they are measured…
can be directly connected to ***quality control*** and ***exposure metrics***

Engineered Nanomaterials are Not Just Pristine

PRISTINE DEGRADED METABOLIZED COMPLEXED



Understanding the physical properties of materials is key to successful consumer product development

Physicochemical properties can have an impact on the product's

- **BULK PROPERTIES**
- **PERFORMANCE**
- **APPEARENCE**
- **PROCESS**
- **STABILITY**

For nanomaterials, here are some of the physicochemical properties researchers should characterize…

- Chemical composition
  - Impurities
- Solubility
- Stability
- Size & size distribution
  - Surface area
- Surface charge
- Surface coating
- Iso-electric point
- Crystalinity
- Aggregation
  - Agglomeration
  - Dissociation
- REDOX capacity
- Shape
  - Aspect ratio
- Rheology
- Phase
  - Powder, aerosol, or suspension
- Mechanical properties
- Thermal properties
- Spectroscopic properties
  - Auto-fluorescence
- Quantum properties
  - Magnetism

…But are all of these critical?

Quality Attributes in Nano-Manufacturing

Consumer products with nano-scopic components are individually complex in terms of structure, function, and performance

The attributes of the nano-scopic component that help define structure, function, and performance include:

1. Size & shape
2. Concentration
3. Surface properties
4. Chemical composition
5. Presumed use
6. Physical formulation (solid or liquid)
7. Route of exposure

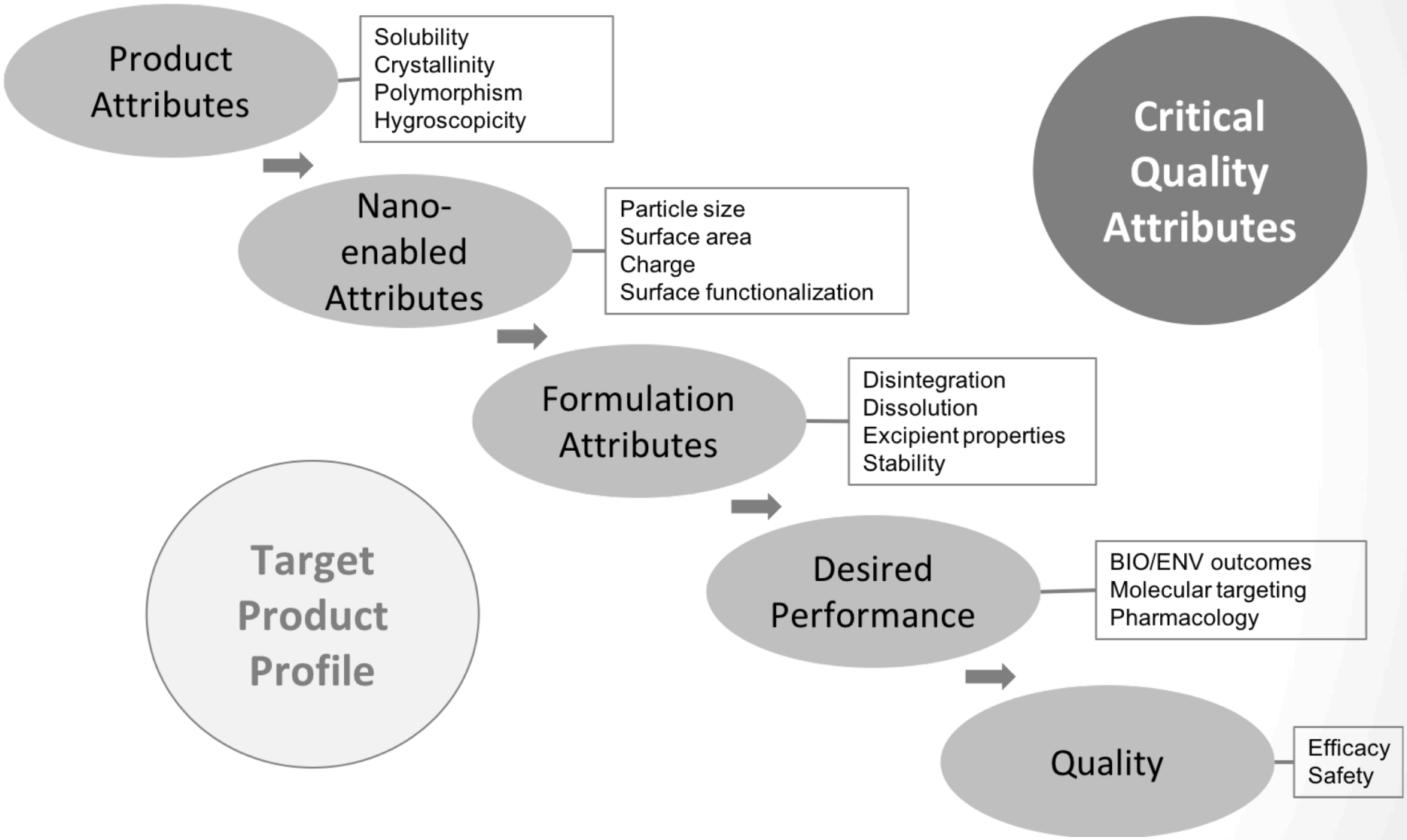


Image adapted from: The AAPS Journal (2016) 19(1):18

Nanoparticles Change in Physiological Fluids

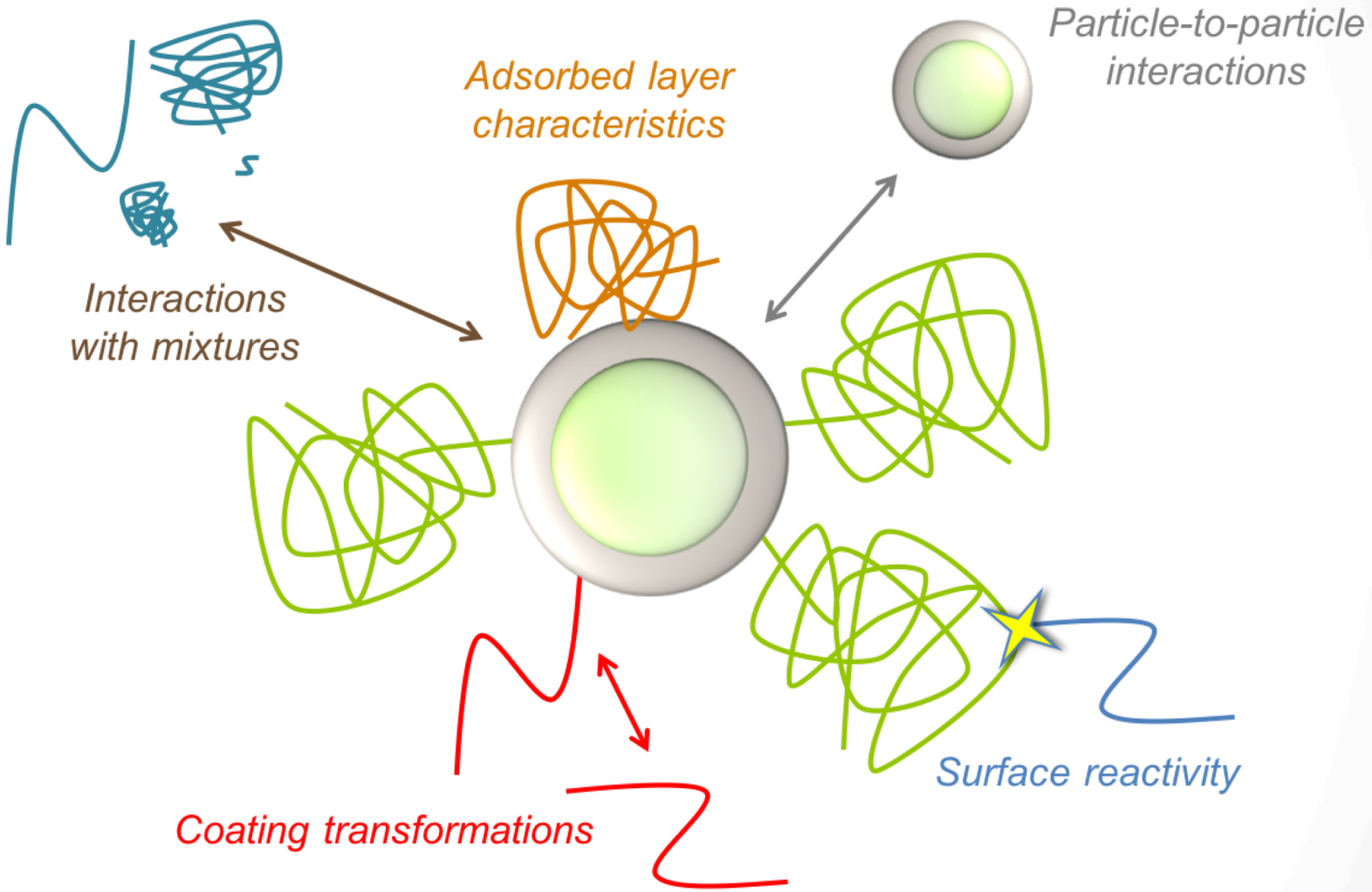
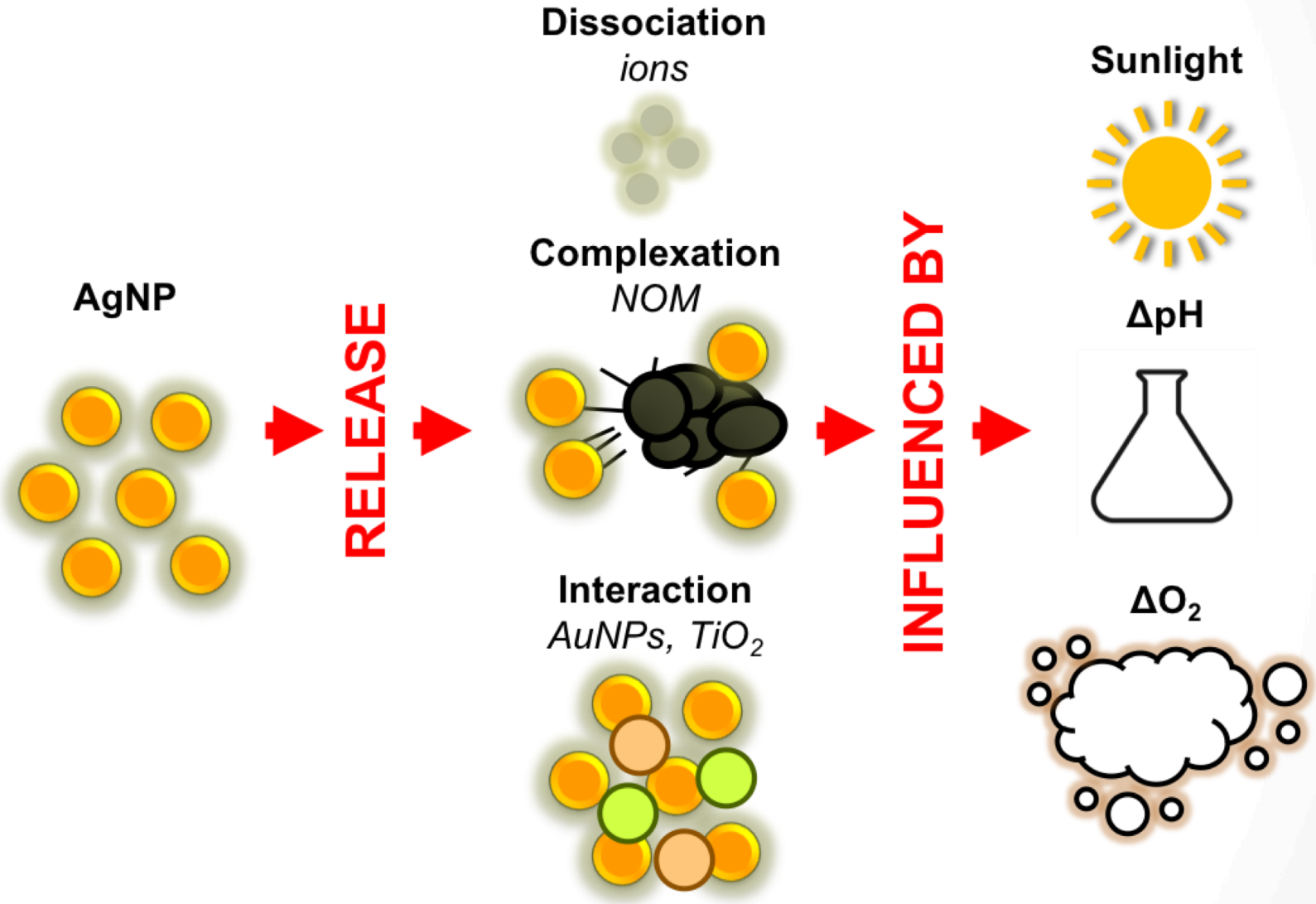
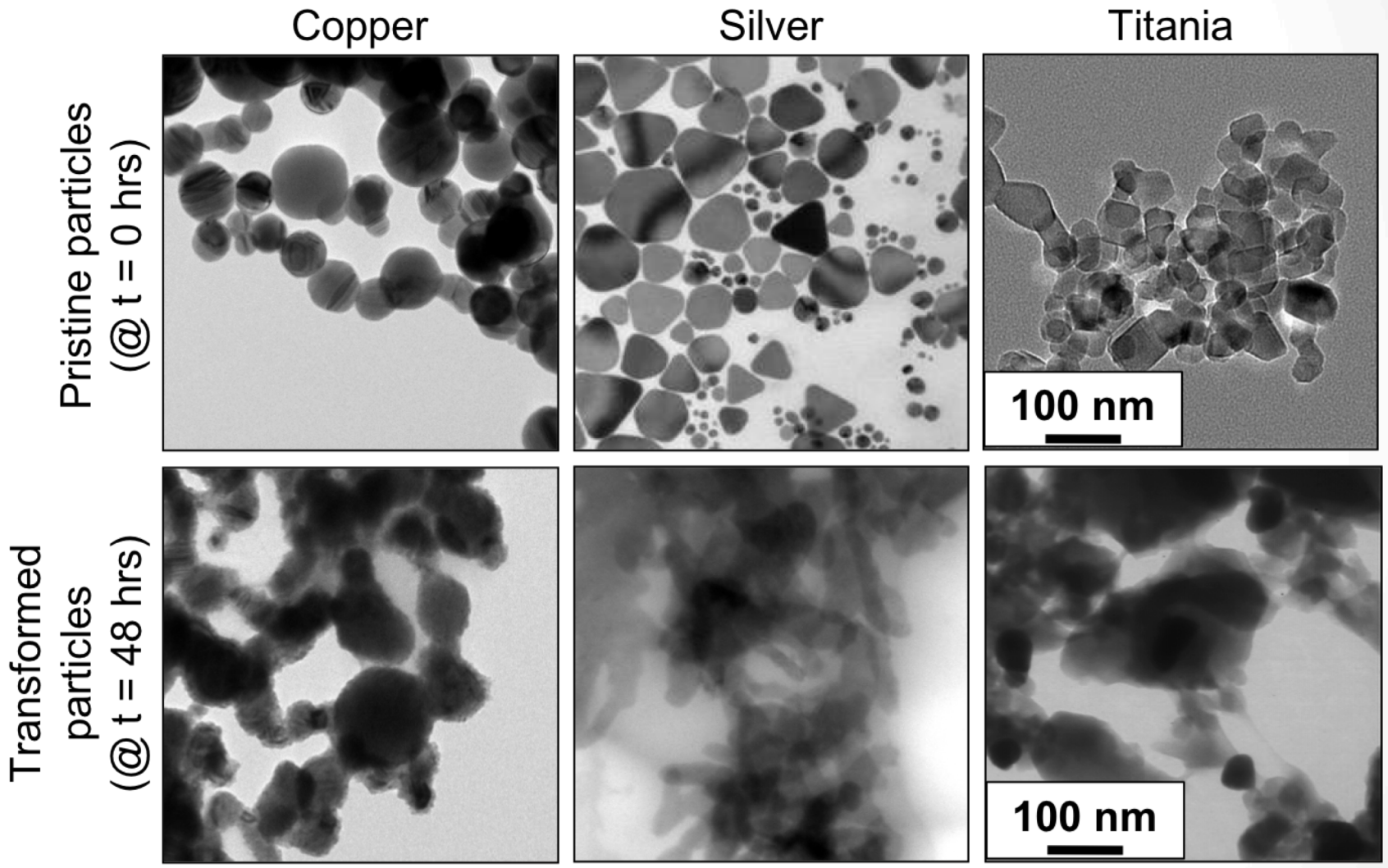


Image adapted from: Environmental Science: Nano. 2016;3(2):283-310

Nanoparticles Change in the Aquatic Environment



Pristine vs. Degraded Materials



Concluding Remarks

- The markets that use engineered nanomaterials are **diverse** and **growing**
  - This results in **occupational, consumer,** and **environmental** exposures
  - **Exposure science** is still under-studied, but should be (can be) measured

- All industries need extensive **physical, chemical, toxicological, and environmental** characterization
  - To assess **risks**, understand **mechanisms** of action, and perform remediation/**mitigation** strategies

The **information about nanoparticles** must consider the following important details:

1. The fundamental property being measured
2. The unique way the property is expressed
3. The measurement technique itself and the instrument employed
4. The way in which the sample is collected and prepared for examination

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