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Integration framework for the development of safe and sustainable nanomaterials



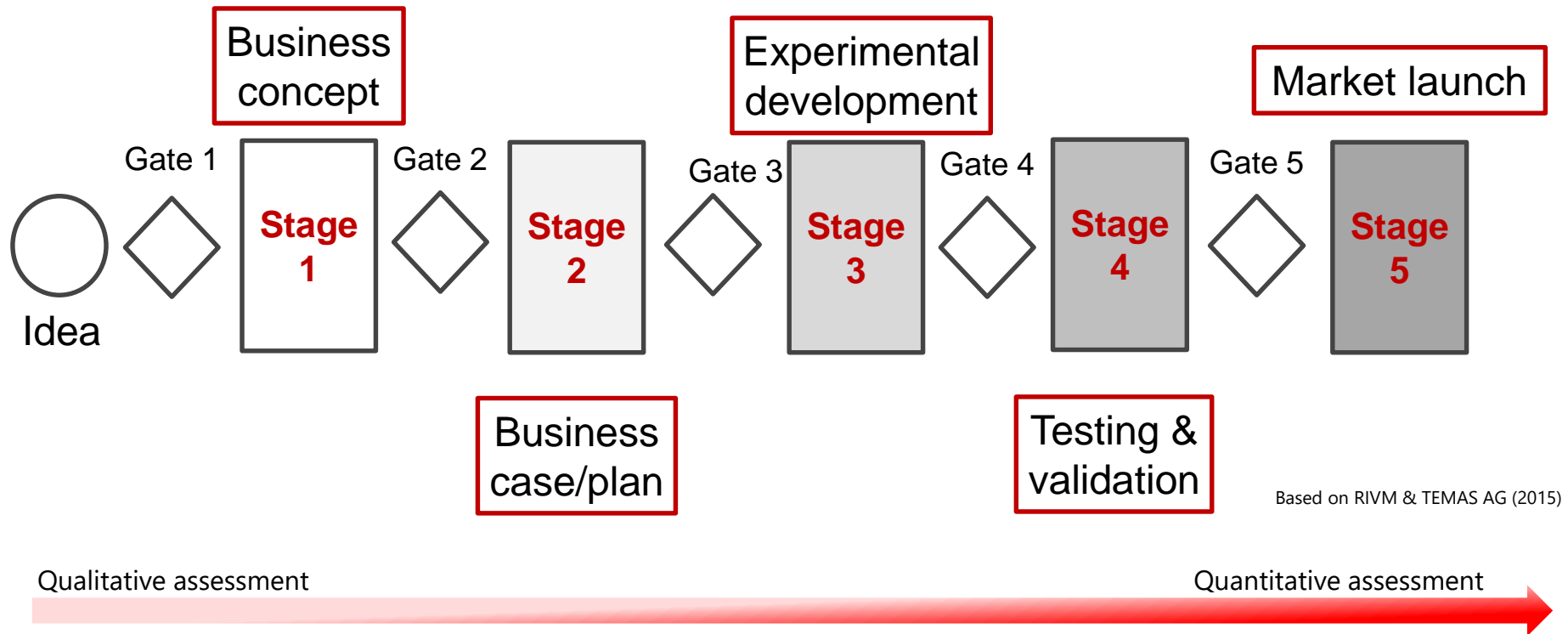
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NanoReg2

- ✓ Establish **Safe by Design (SbD)** as fundamental pillar in the validation **of nanomaterials**
- ✓ Sbd aims to **identify & minimise potential risks** to human health & the environment that may occur along the product's **life cycle** from **early stages** in the product development process

NanoReg2 – SbD framework for MNMs

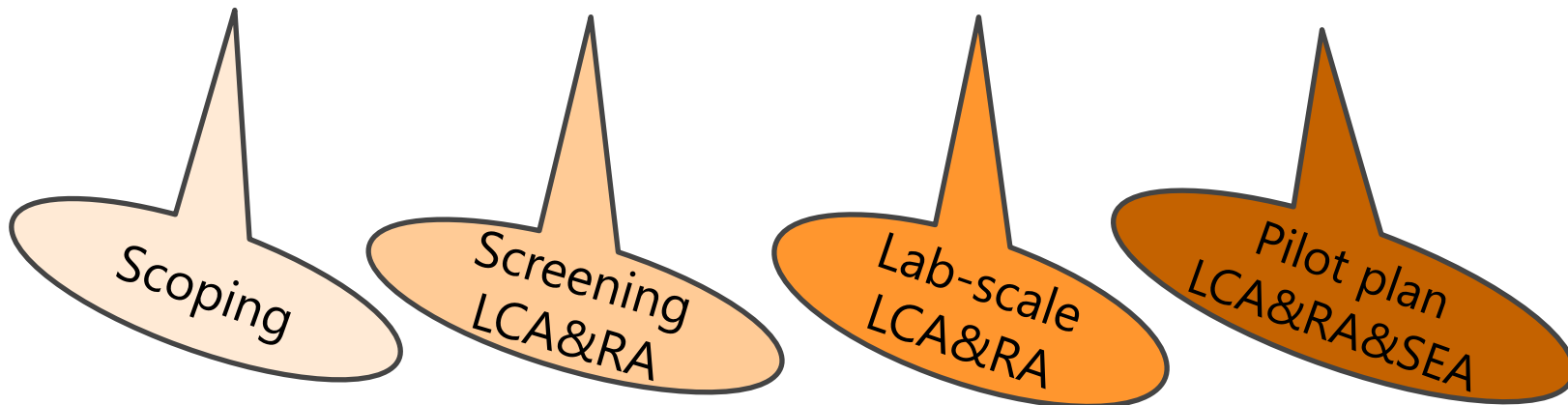
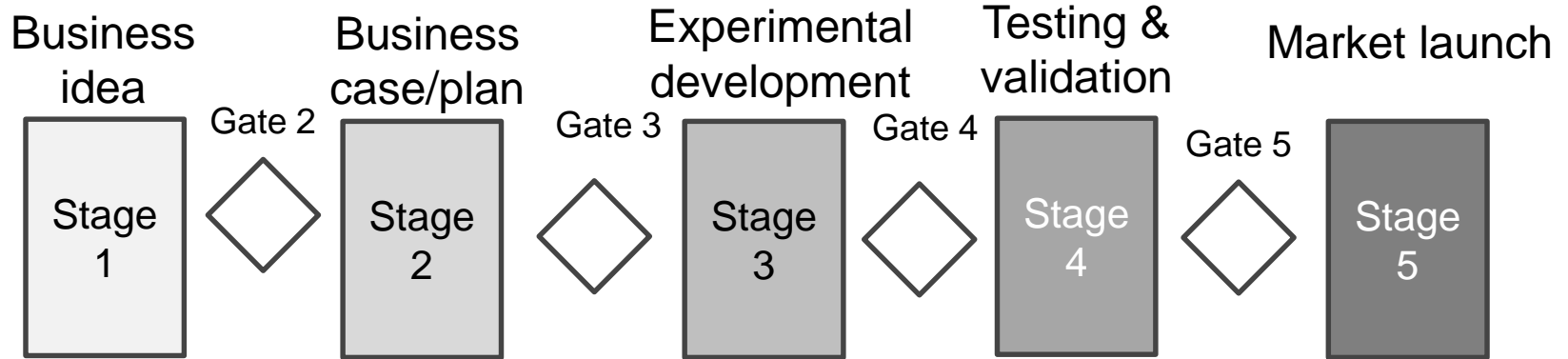
Standard “stage (work phase) - gate (checkpoint)” model



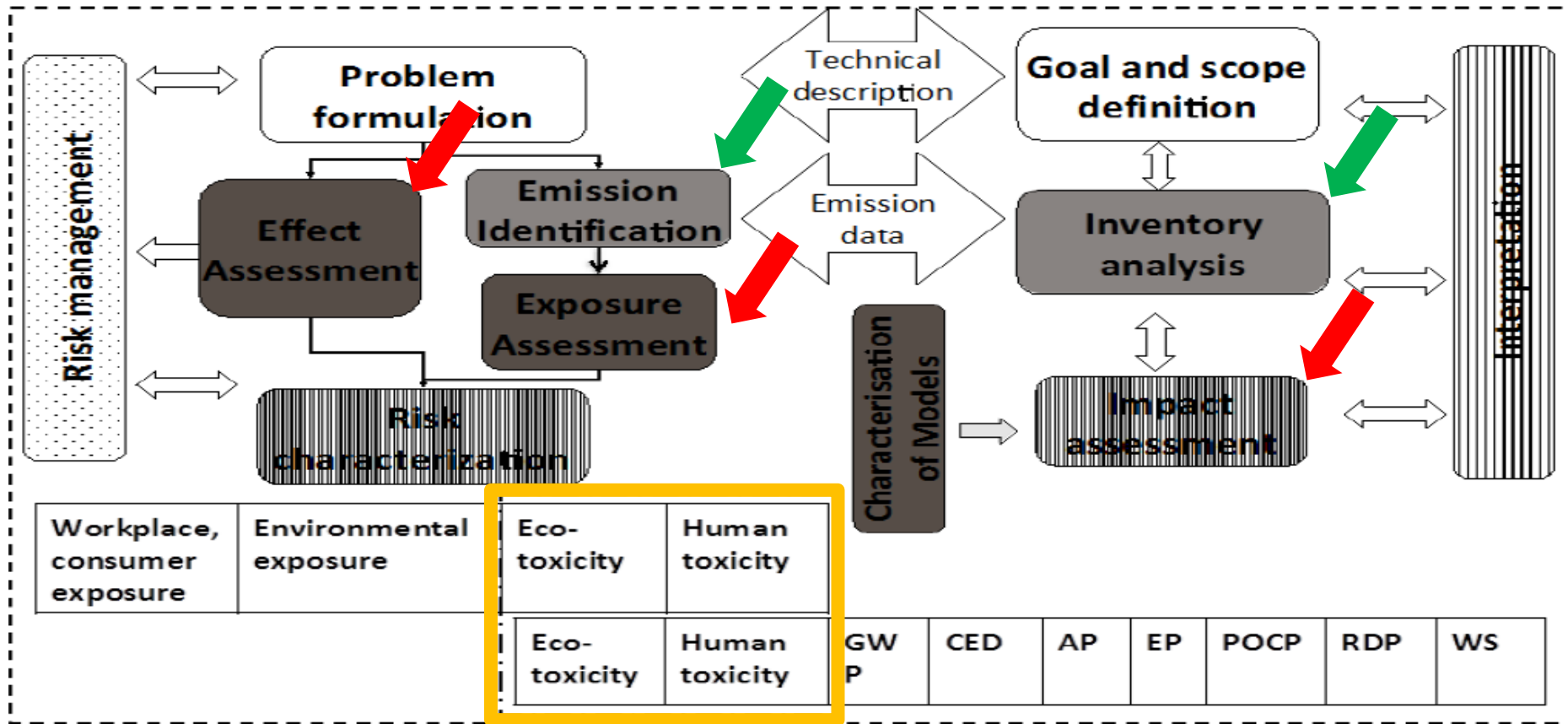
- RA-based activities: Occupational/product/consumer/environmental safety
- RA-based tools are applied
- Regulatory requirements (REACH) are accounted (e.g. Stage 5)

Sustainability metric into Sbd

Risk-based Sbd concept → **sustainability- & risk-based** Sbd concept



LCA & RA



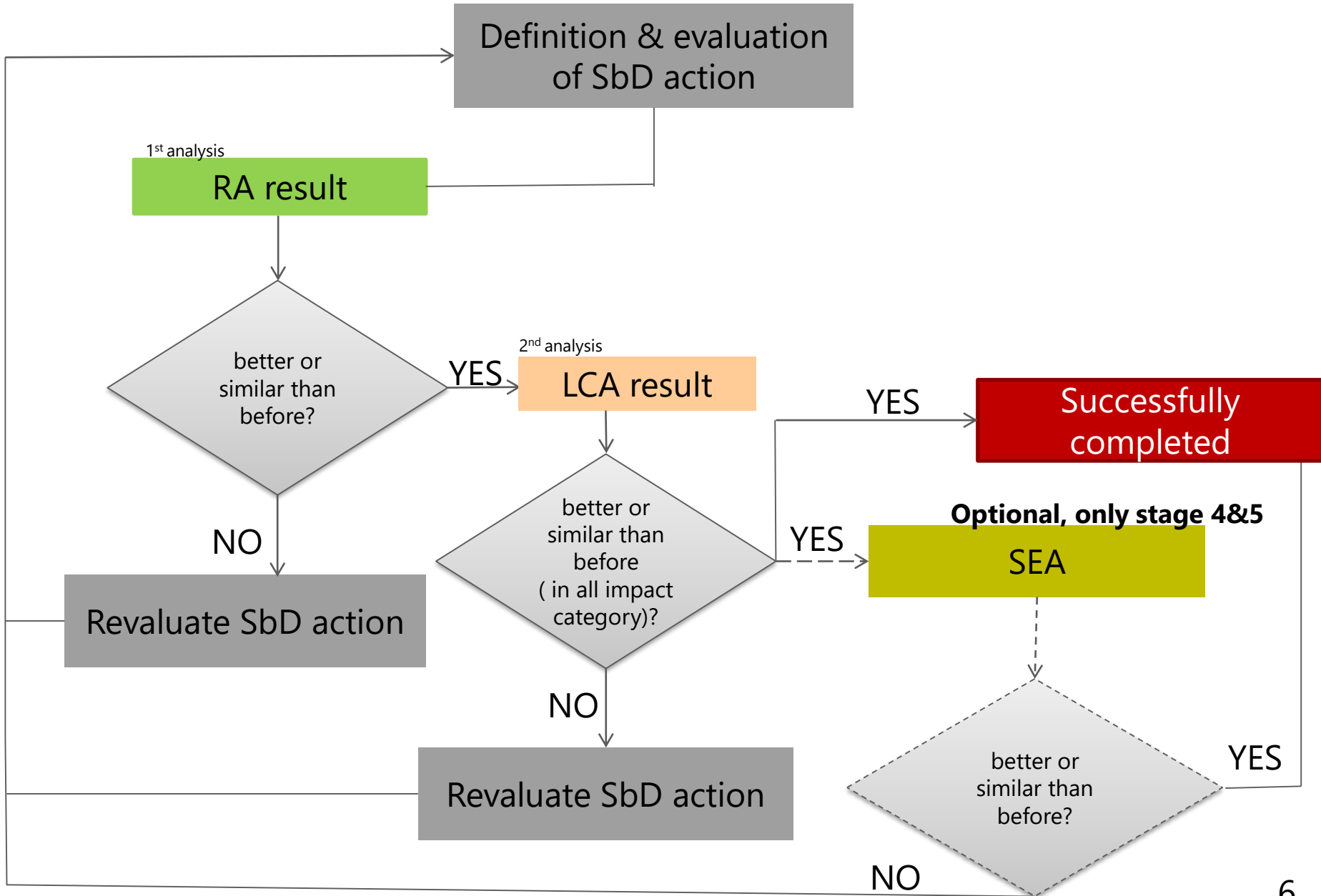
Global warming Potential (GWP); Cumulative Energy Demand (CED); Acidification Potential (AP); Eutrophication Potential (EP); Photochemical Ozone Creation Potential (POCP); Resource Depletion Potential (RDP); Water Scarcity (WS)

Source: adapted from Barberio (2014)

LCA ↔ RA: share same conceptual framework to assess the toxicity of substances

RA data: applied into LCIA framework to characterize the toxic impact categories

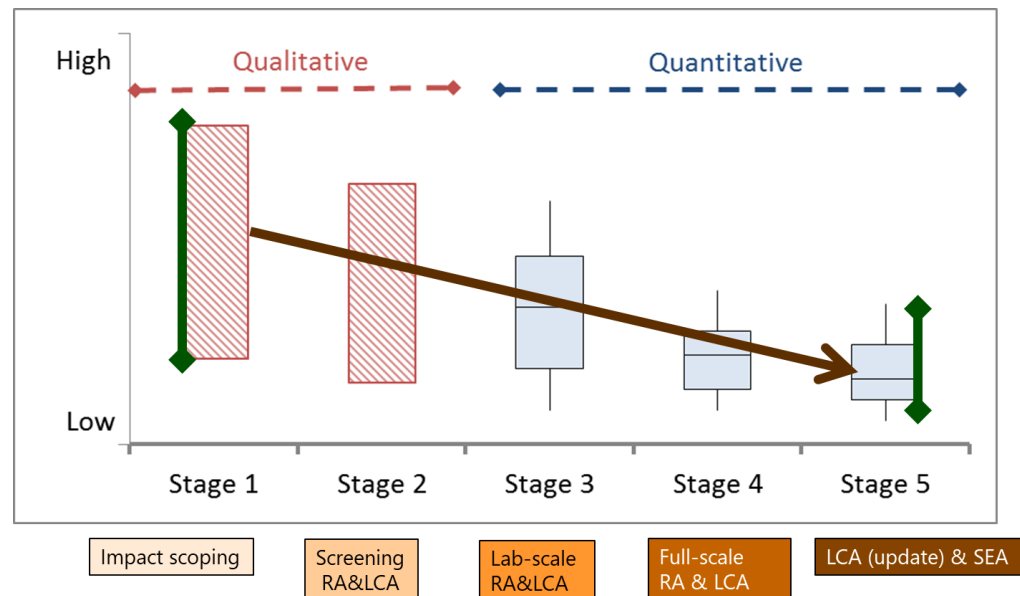
Integration Framework



- Result is an **integrative approach** combining in a meaningful, stepwise way RA, LCA & SEA, resulting in a **coherent methodology** that supports (i) SbD efforts, and (ii) guides industry in a structured way to **perform both, safety and sustainability evaluations** along a development process.
- Results of site-specific RA activities can be integrated into the general LCIA framework in order to evaluate more accurately toxicological impacts
- SEA can be performed at stages 4 & 5 when LCA data are available


Conclusions

- **Developed by using 6 industry cases studies**, representing different stages of the innovation process (from business ideas/concept to pilot production and market entry) and different type of NMs (Graphene, CNF, Ag nanowires, Ag nanoparticles, Si-based NMs)
- Along the stage-gate model **reduction of uncertainty** can be achieved due to the **rising amount of available data** – allowing to apply different tools in a more detailed manner the later in the development process (i.e. the higher the stage ...).



Thank you for your attention

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NanoReg²