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# *Physical and physiological mechanisms of nanoparticle toxicity*

ABSTRACT:
Engineered nanomaterials (ENMs) straddle the boundary between the atomic and molecular scale and because of this, they exhibit unique physical, chemical, and electronic properties. Their extremely high surface area to volume ratio in combination with these unique properties, make ENMs desirable in a multitude of applications including environmental remediation, medical imaging, and personal care products.  Unfortunately, these same characteristics also make it difficult to predict the toxicity of novel ENMs based on available information for conventional materials.  ENMs are now found in thousands of consumer products and there is a growing need to characterize their potential risks to human and environmental health. We examine these questions at multiple scales ranging from purified proteins, to isolated cells, to in vivo studies on organ physiology and energetics.  We exploit the tunable nature of ENMs to address how their physicochemical properties (e.g. size, shape, surface charge, chemical composition, etc.) influence their interactions with proteins, membranes, and metabolites in vitro.  This data is then applied to higher level studies on the biological and ecological relevance of 'nanotoxicity' using fish as model systems.  We specifically focus on the cardiorespiratory system, as the pathology of chronic metabolic and/or physiological stress is often manifested in the form of cardiovascular dysfunction. Identifying the properties which contribute to ENM bioactivity will allow industry to design safe nano-enabled products and provide regulators with the necessary data to make informed decisions on novel ENMs.  The end goal of this research is to facilitate the responsible development of nanotechnology applications aimed at addressing critical issues in human and environmental health.