

# Global RNA Sequencing of *Escherichia coli* from Exposure to Nanodiamonds and Carbon Nanotubes with Surface Coatings

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## Introduction

- Engineered nanomaterials come in different shapes, sizes, compositions and surface coatings.
- Novel materials are driving innovation with many different and specific applications.
- There will be inevitable release of nanomaterials to the environment, with concerns for microbes.

## Physico-chemical Properties

Material	Uncoated		COOH-coated		Ammonium-coated		PEG-coated	
	Size (nm)	Exposure (mg/L)	Size (nm)	Exposure (mg/L)	Size (nm)	Exposure (mg/L)	Size (nm)	Exposure (mg/L)
Nanodiamonds	-	-	59.00 ± 5.57	100	55.33 ± 17.03	100	68.00 ± 5.13	100
Multi-walled carbon nanotubes	28.67 ± 2.33	25	42.33 ± 9.02	25	42.33 ± 7.22	25	64.67 ± 14.84	25

Amine functional coating (-NH<sub>2</sub>) for MWCNTs; Nominal exposure concentrations (*n* = 3). More information in Vassallo et al, 2018: <https://doi.org/10.1016/j.ecoenv.2018.06.085>

## Global RNA Sequencing of *E. coli* K-12 MG1655

1. Do changes in RNA expression reflect the toxicity ranking from the *in vivo* results?
2. Is there a coating effect on the RNA profiles of *E. coli* K-12?

## Bacterial Biomass (*in vivo*)

(1a)

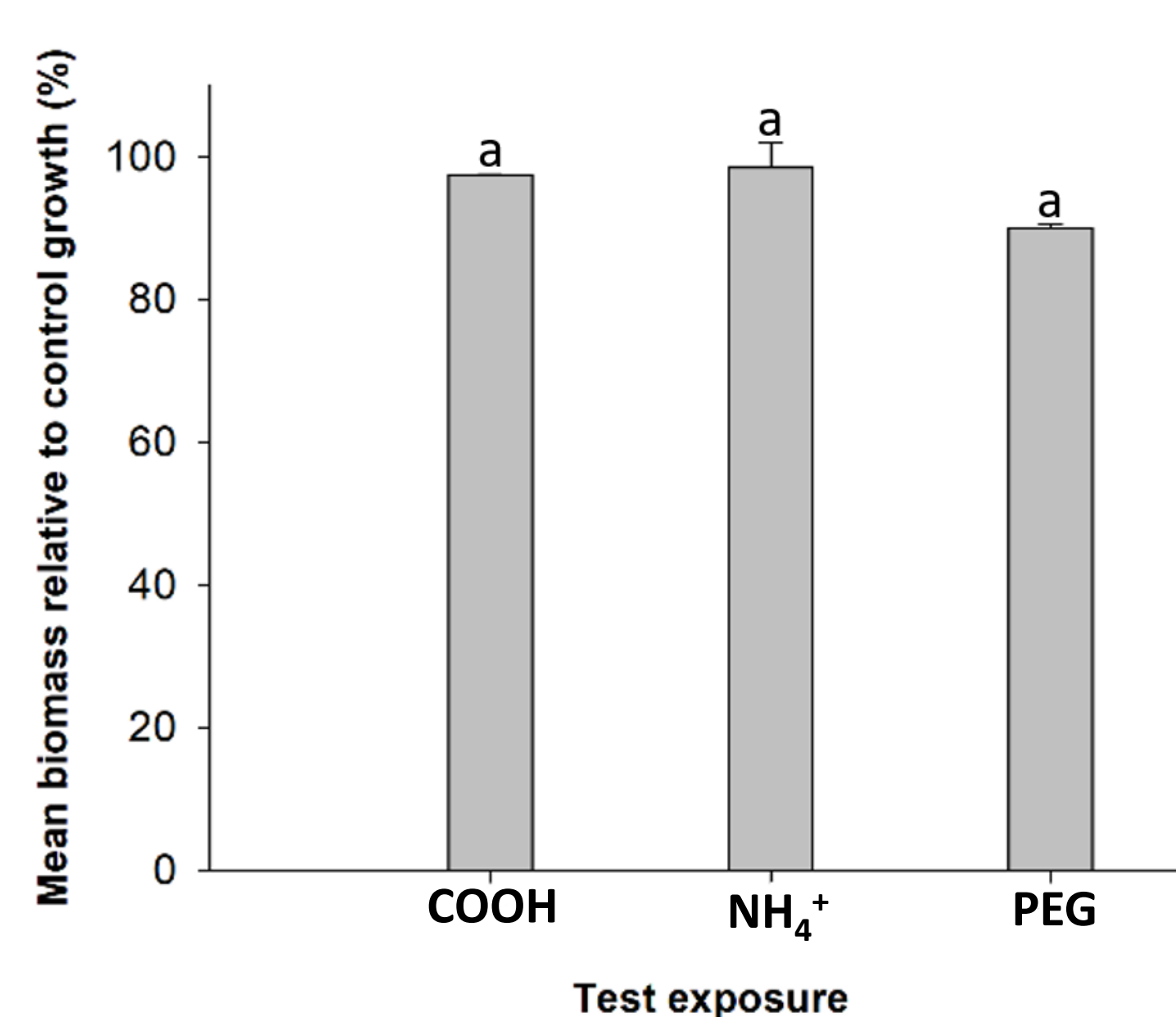


Figure 1a: Nanodiamonds.

(1b)

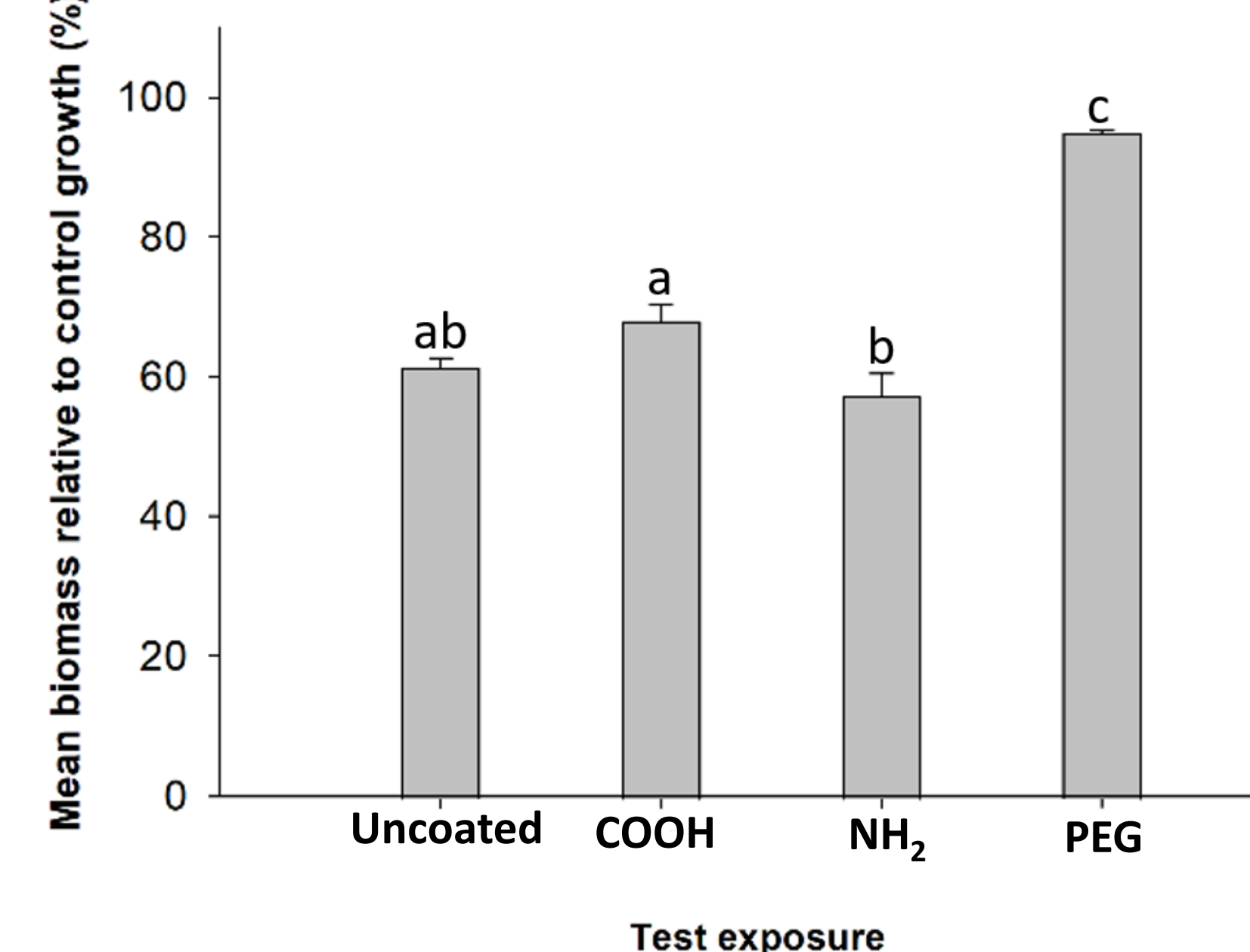


Figure 1b: Multi-walled carbon nanotubes.

## Global RNA Sequencing

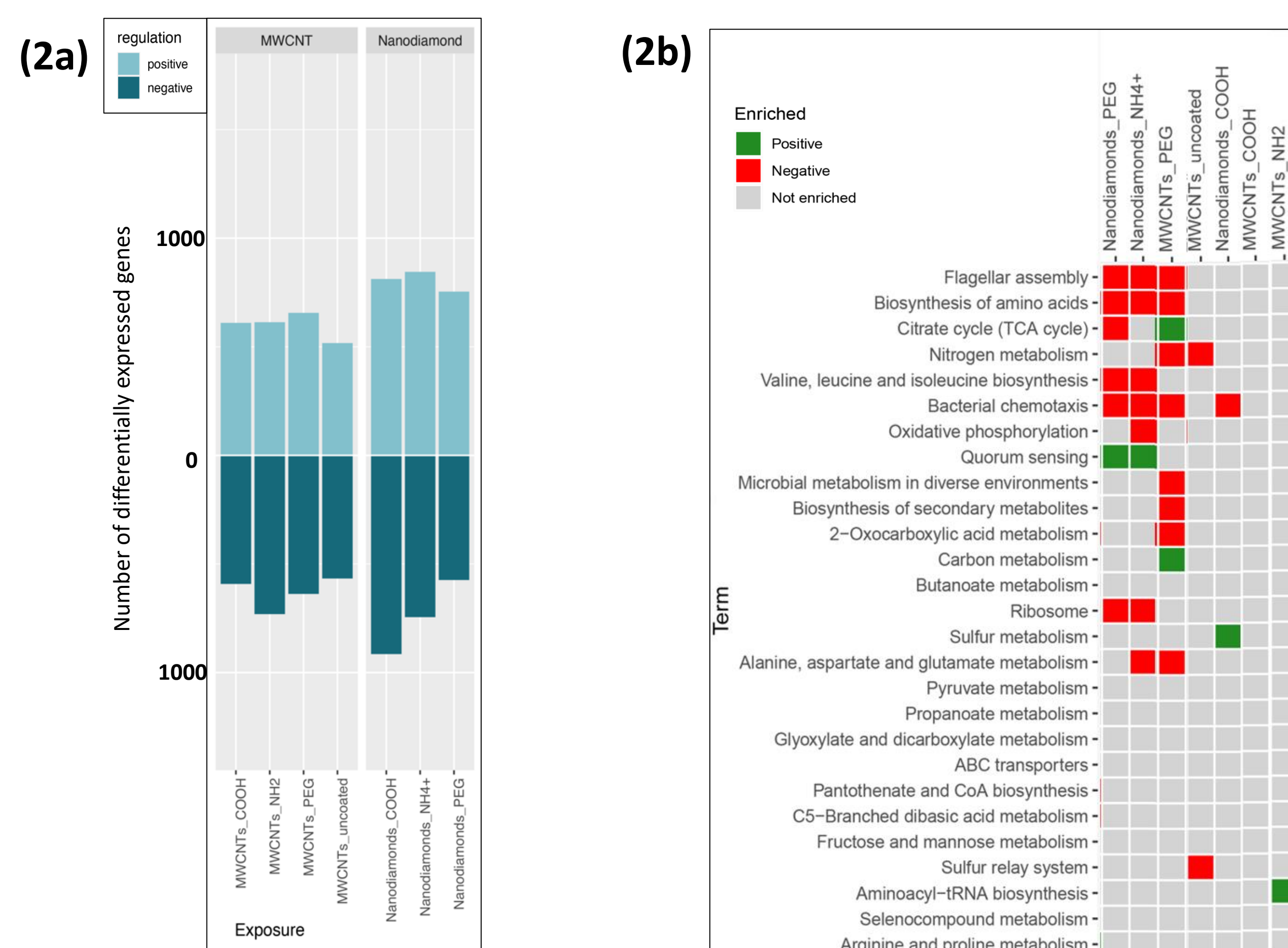


Figure 2a: Differentially expressed genes are filtered by absolute fold-change > 2 and adjusted *p* < 0.01.

Figure 2b: Kyoto Encyclopedia of Genes and Genomes (KEGG) pathway mapping.

## Results

- Bacterial growth inhibitory effects were associated with the chemistry of the materials, exposure concentration, particle behaviour and the surface chemistry of the coatings.
- Observations are based on messenger RNA abundance of the exposures to different materials relative to the unexposed bacterial growth control.
- A large proportion of genes is deregulated in all conditions (Figure 2a).
- Nanodiamonds display negative effects/down-regulation for an 'inert' material (Figure 2b).

## Conclusions

- Global RNA sequencing detected differences in gene expression that suggest material-type effects, and specific coating effects.
- The coating is only one factor in material properties.
- Omics can be used as a pivotal tool to help resolve complexity.

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