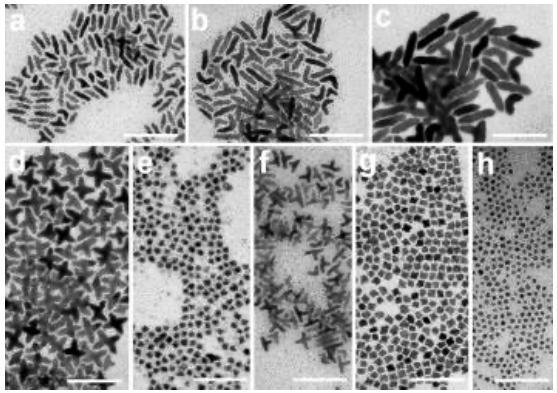
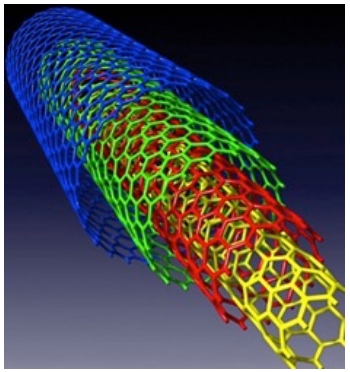
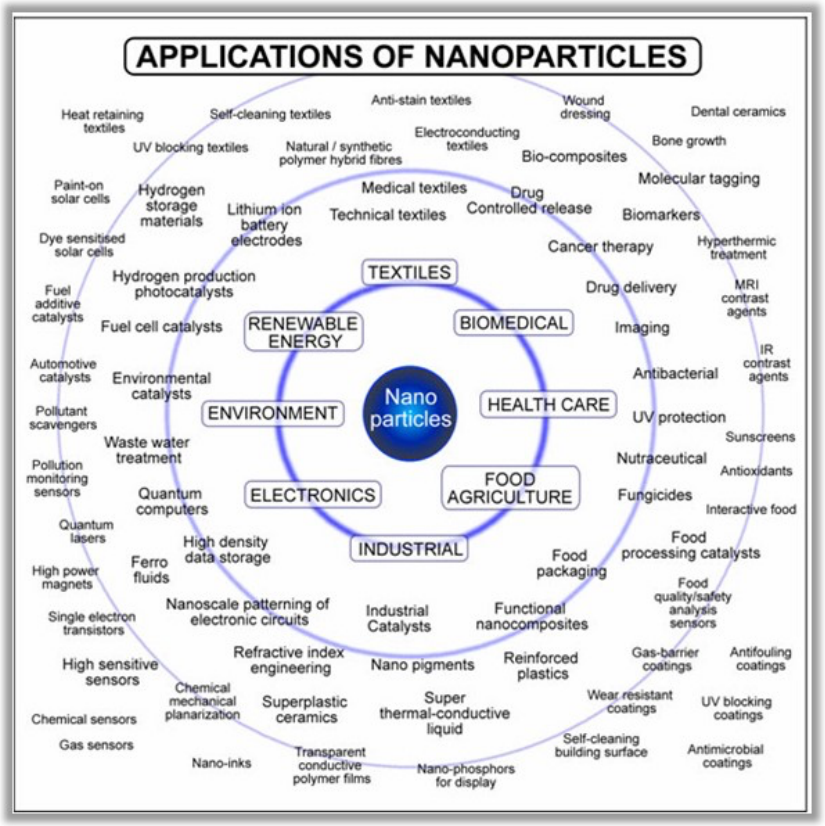
INVESTIGATING THE INTERACTIVE EFFECTS OF NANOMATERIALS AND POLLUTANTS IN WATER ECOSYSTEM: A CASE STUDY WITH CARBON-BASED NANOMATERIALS AND BENZO(α)PYRENE

Camilla Della Torre, Dept. of Biosciences University of Milan, Round table Ecosystem health and chemical mixture risk assessment and management

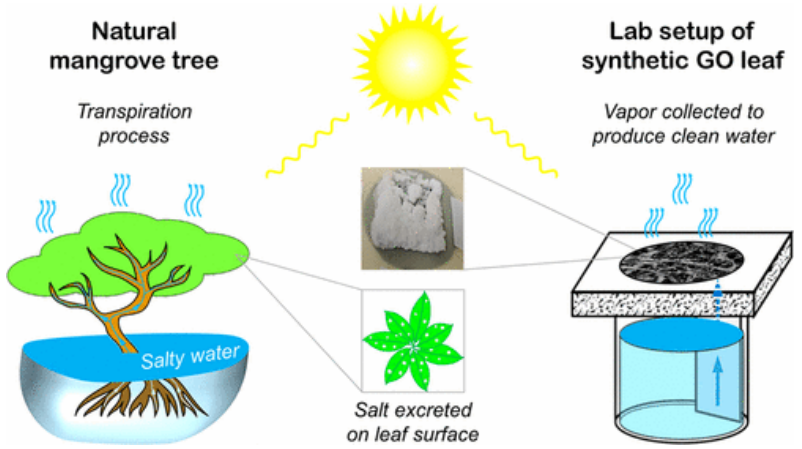
NANOMATERIALS

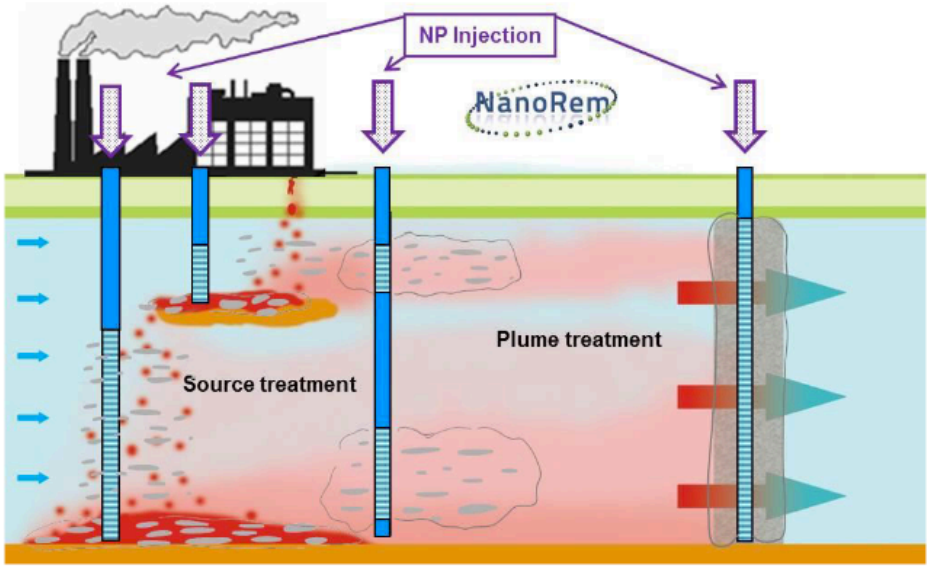




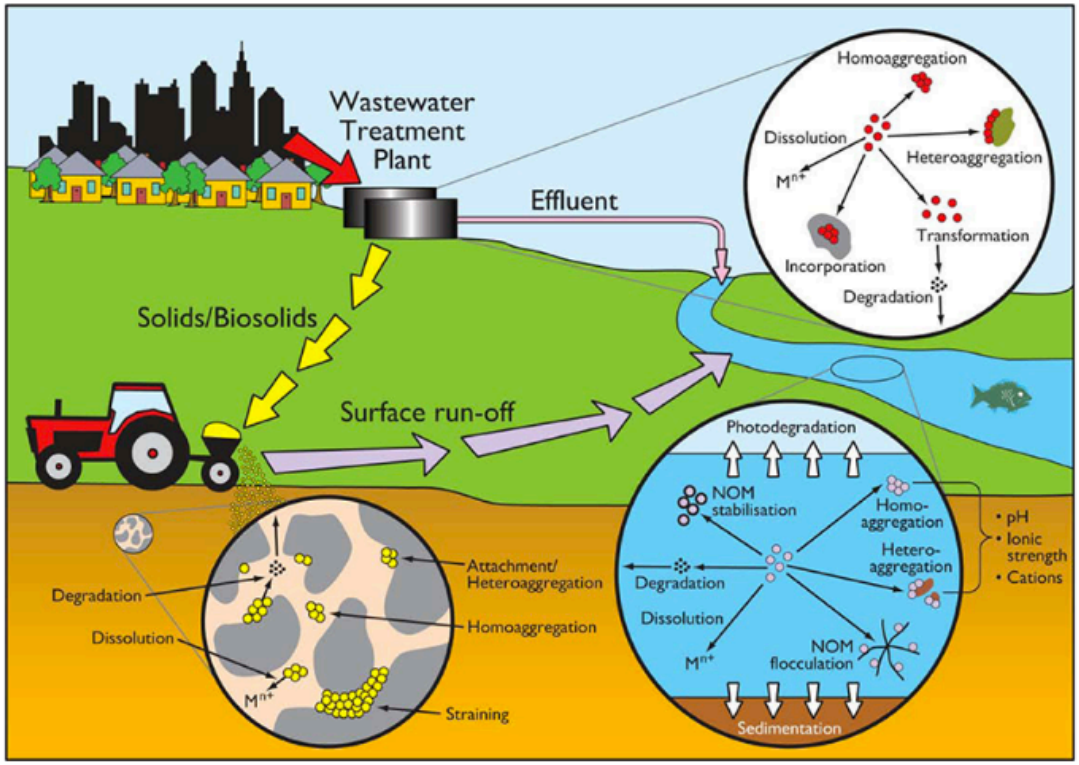


Nanotechnology and environmental sustainability



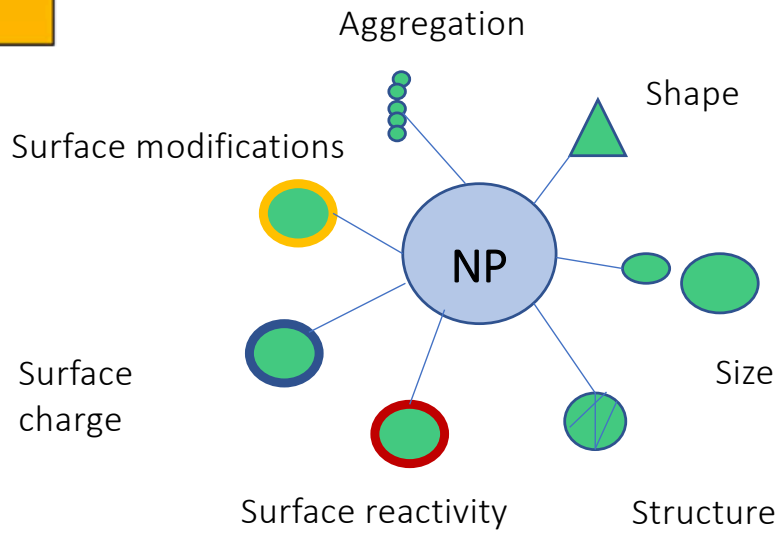


ENVIRONMENTAL FATE



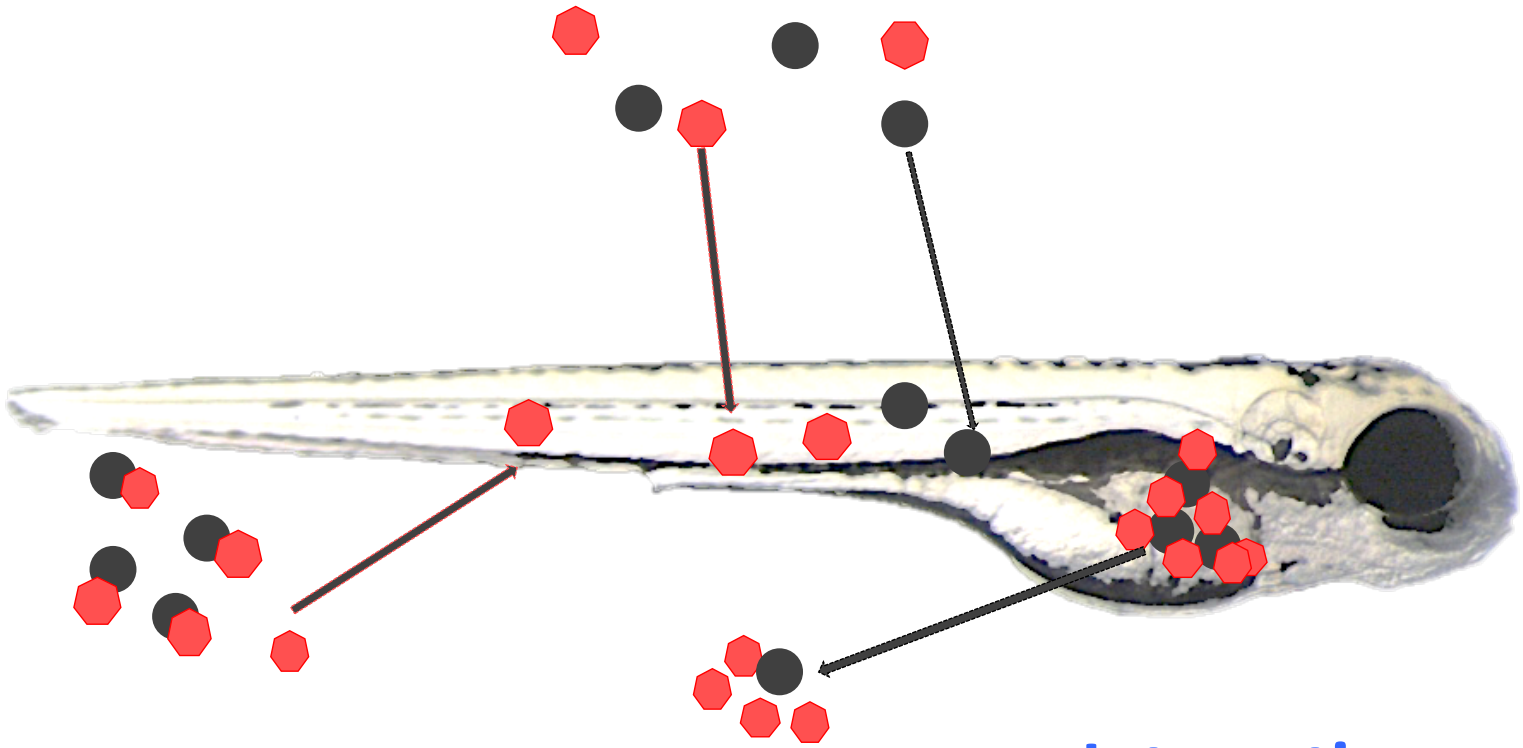
Batley et al., 2013

TOXICITY



NMs + Chemical Pollutants

No Interaction



Interaction

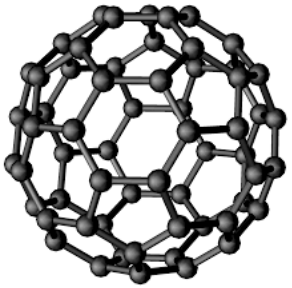
NMs sequester CP

Interaction

NMs increase CP bioavailability/toxicity

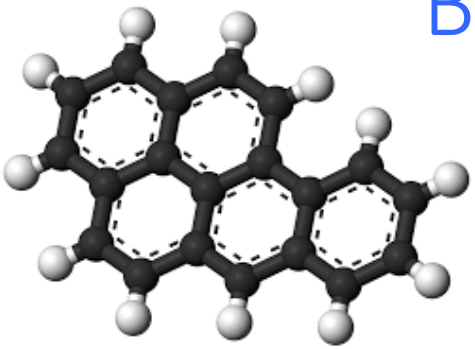
Trojan Horse Mechanism

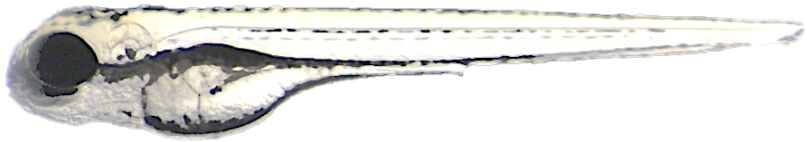
CNPW



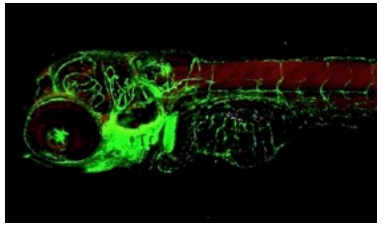
C_{60}

B(α)P



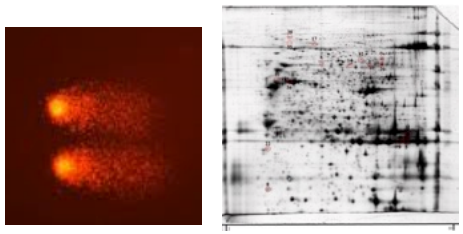


Physico-chemical interactions

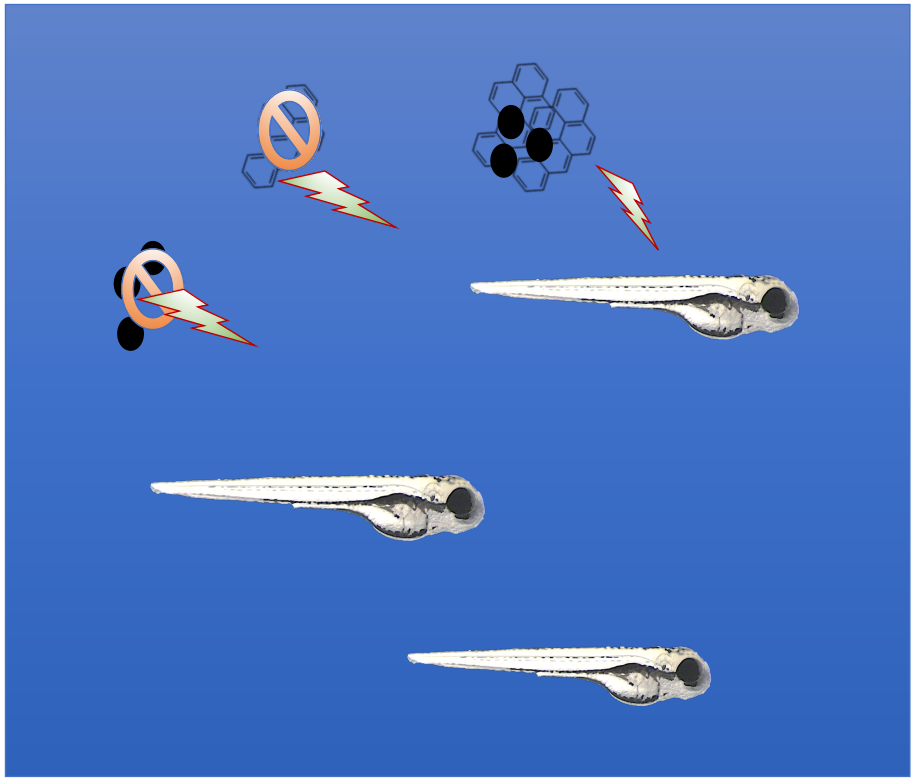


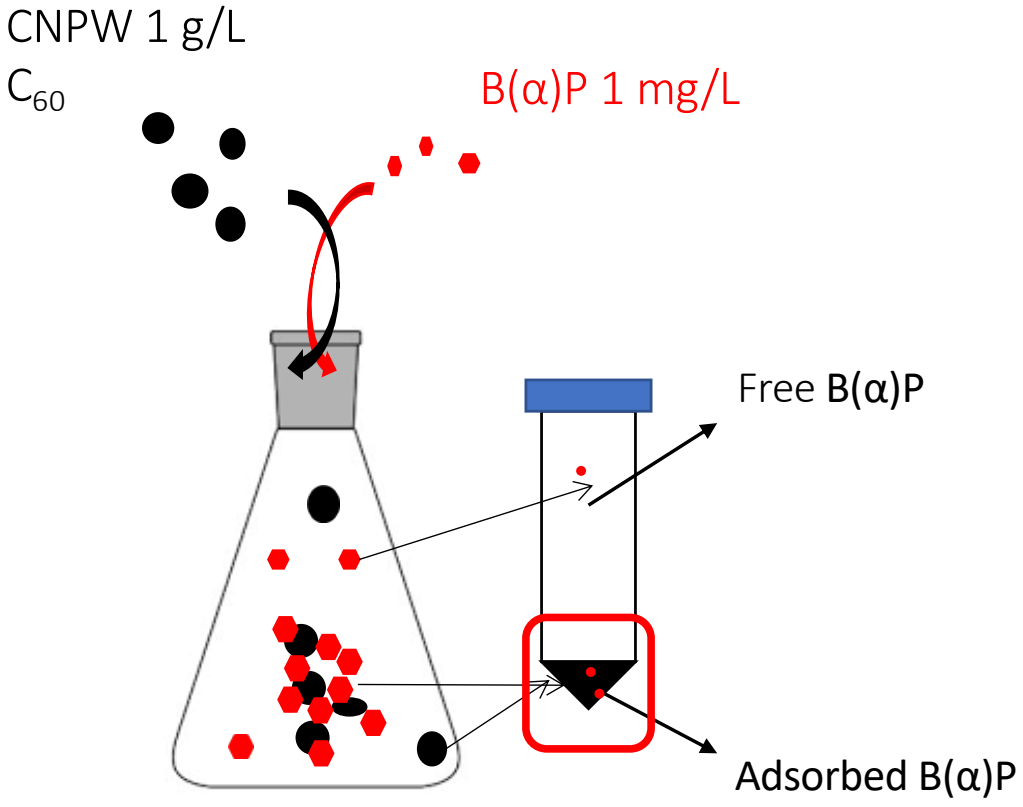
uptake/distribution

TOXICITY



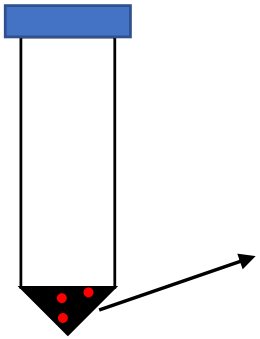
Doping of NMs





Sample	B(α)P in H_2O (%)	B(α)P adsorption on CNM µg/g
CNPW + B(α)P	0.071	344
C60 + B(α)P	2.90	387

Rehydratation



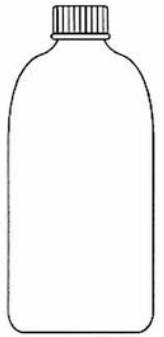
CNPW 50 mg/L

CNPW 50 mg/L
+ B(α)P 20 µg/L

C60 20 mg/L

C60 20 mg/L
+ B(α)P 8 µg/L

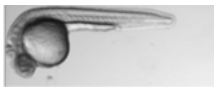
B(α)P DMSO



8 µg/L
20 µg/L

EXPOSURE

Start 24 hpf



End 96 hpf

CTRL

DMSO

B(α)P 8 µg/L

B(α)P 20 µg/L

CNPW 50 mg/L

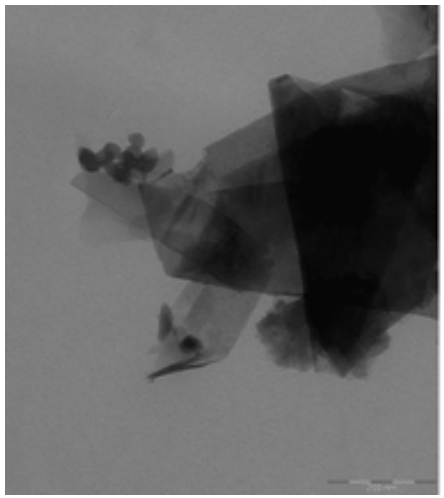
CNPW 50 mg/L+B(α)P 20 µg/L

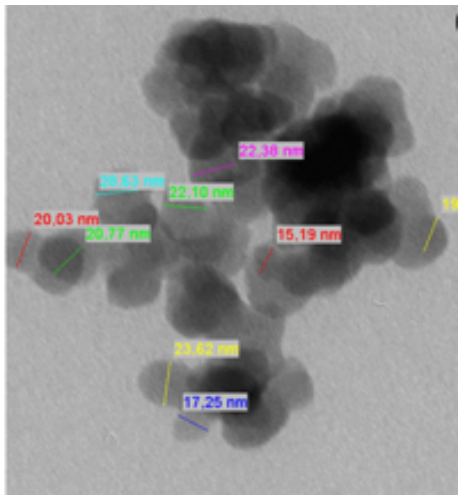
C60 20 µg/L

C60 20 mg/L+B(α)P 8 µg/L

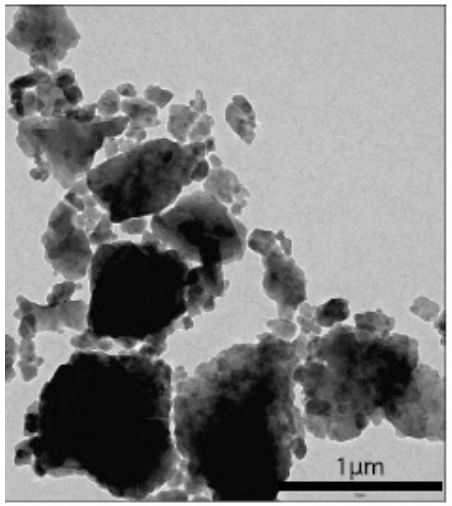
CHARACTERIZATION

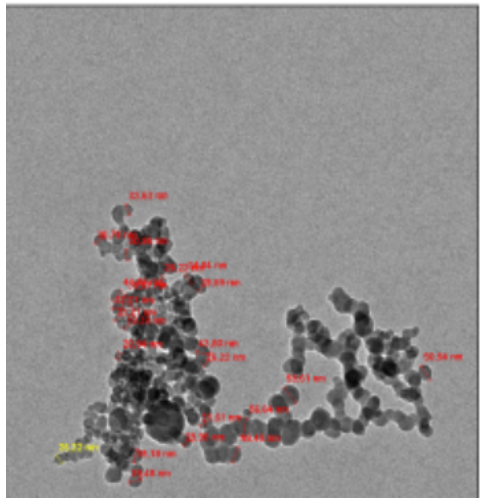
CNPW





C_{60}

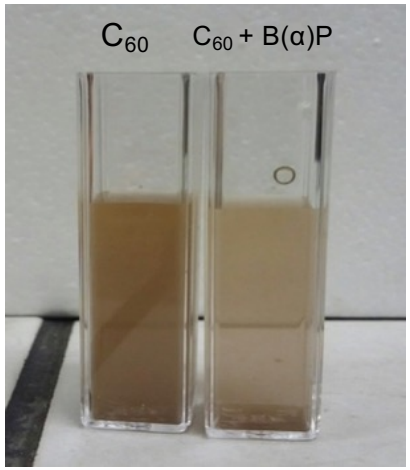


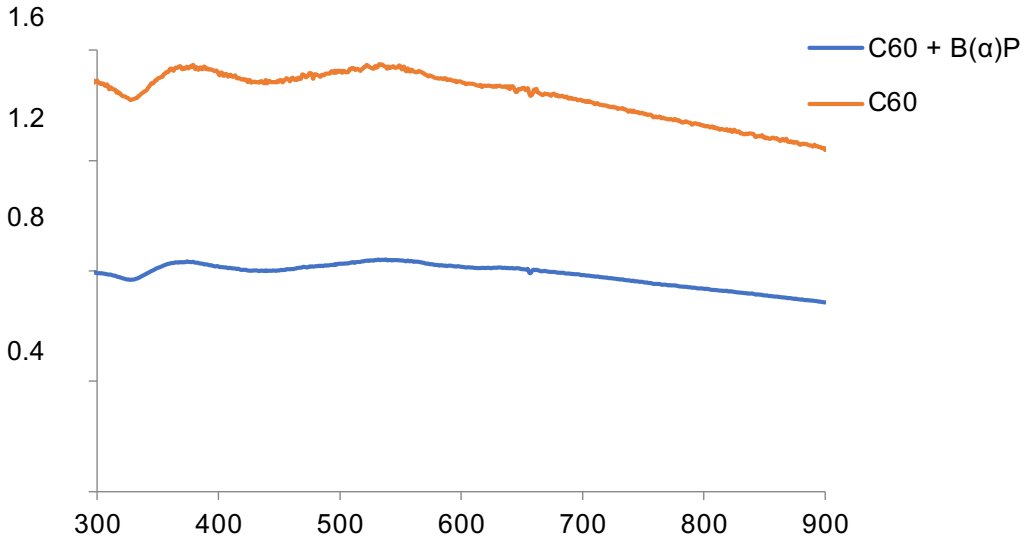


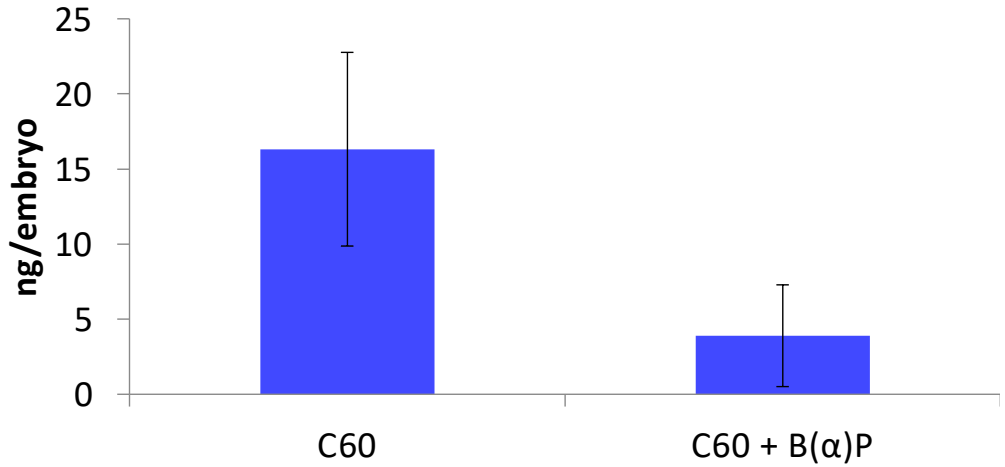
Sample	Z average nm (size range)
CNPW MilliQ 1g/L	822 (607 – 986)
C_{60} MilliQ 1g/L	519 (414 - 714)
CNPW 50 mg/L ZFW	356 (271 – 482)
CNPW + B(α)P 20	419 (171 – 445)
C_{60} 20 mg/L ZFW	899 (848 – 941)
C_{60} + B(α)P 8	767 (174 – 807)

Sample	Z potential mV
CNPW MilliQ 1g/L	-30.9 ± 3.05
C_{60} MilliQ 1g/L	-36.0 ± 1.0
CNPW 50 mg/L ZFW	-20.7 ± 1.15
CNPW + B(α)P 20	-20.1 ± 3.12
C_{60} 20 mg/L ZFW	-21.6 ± 0.25
C_{60} + B(α)P 8	-23.4 ± 0.21

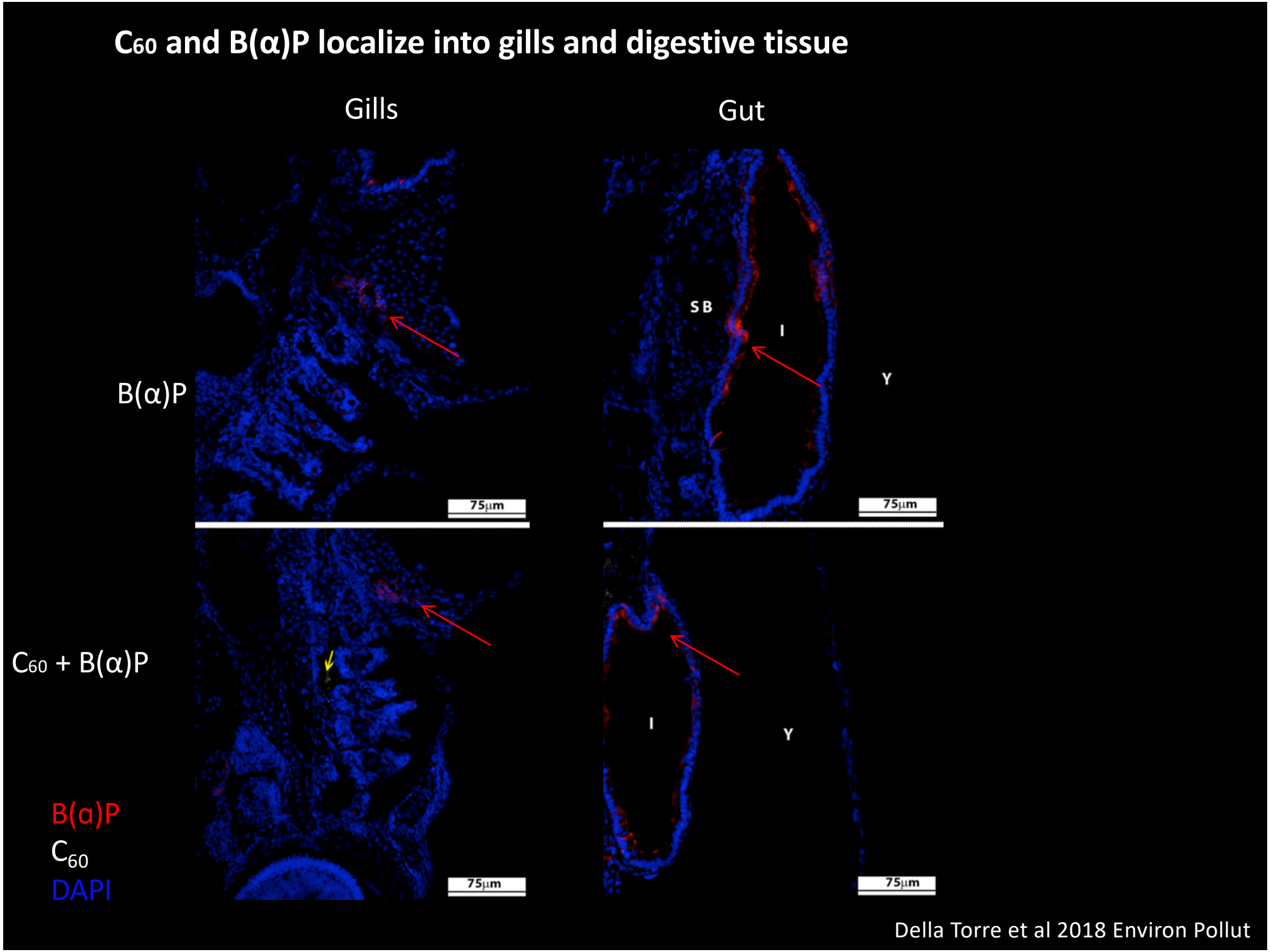
B(α)P adsorption enhance C_{60} sedimentation and reduces C_{60} uptake by embryos







C_{60} and B(α)P localize into gills and digestive tissue



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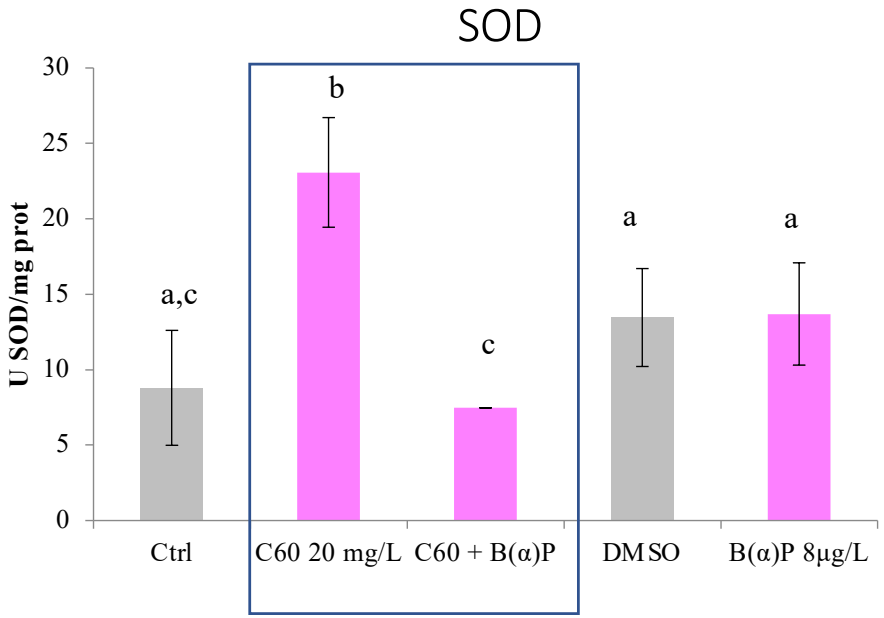
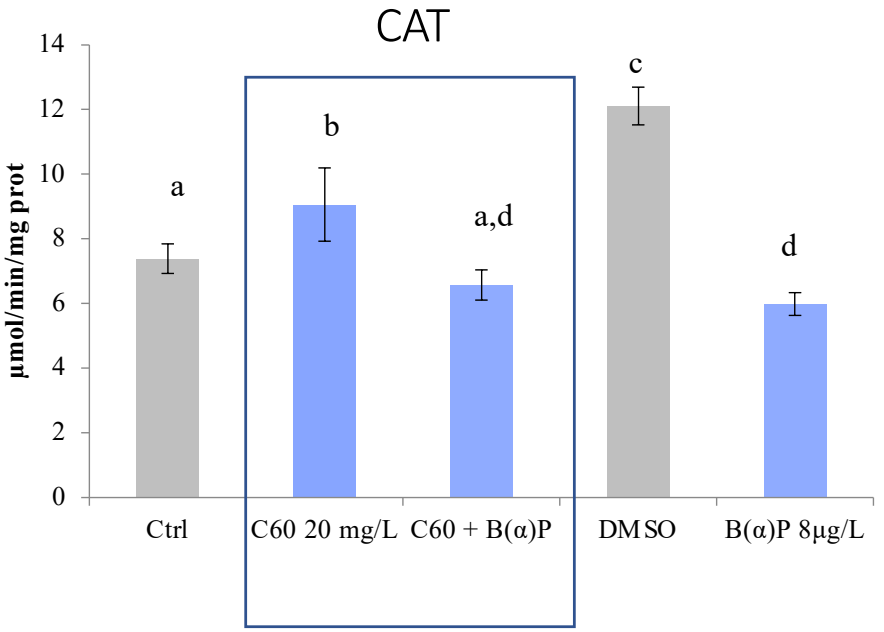
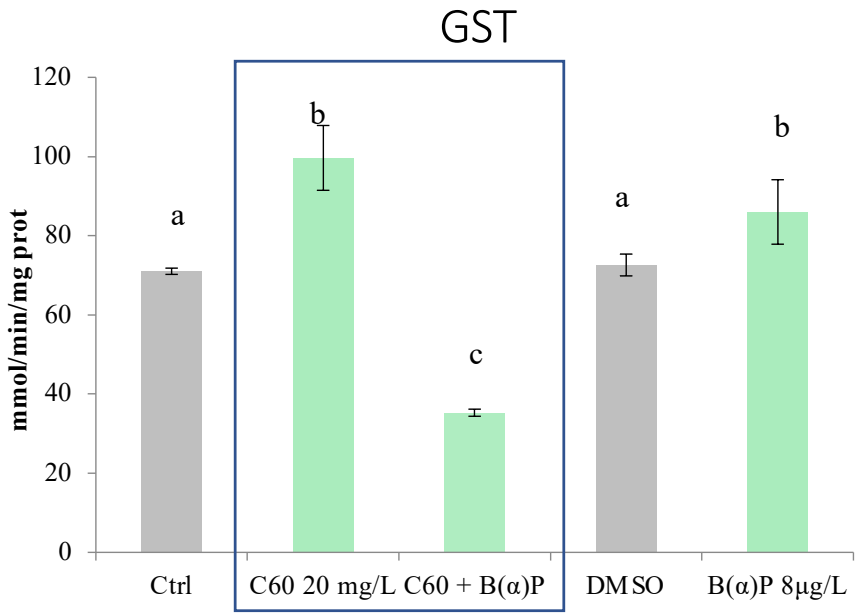
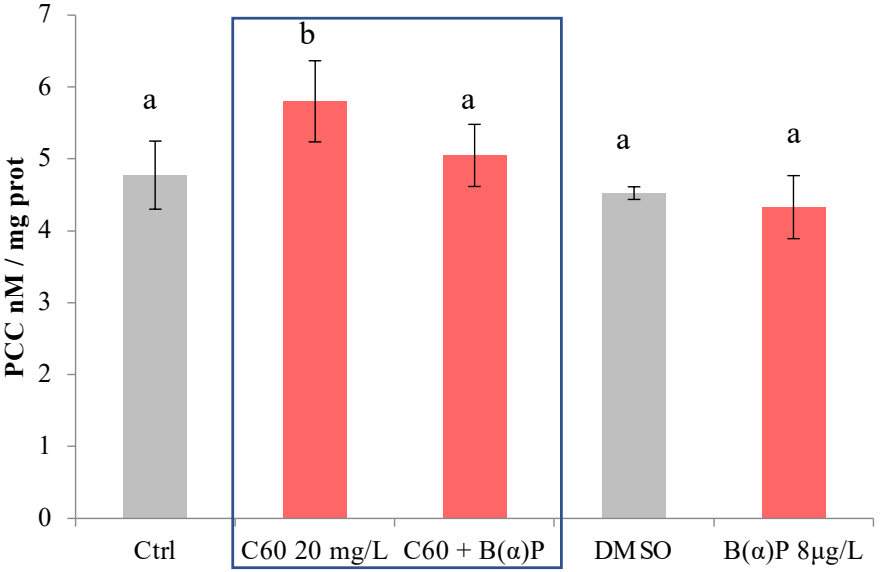
Oxidative stress









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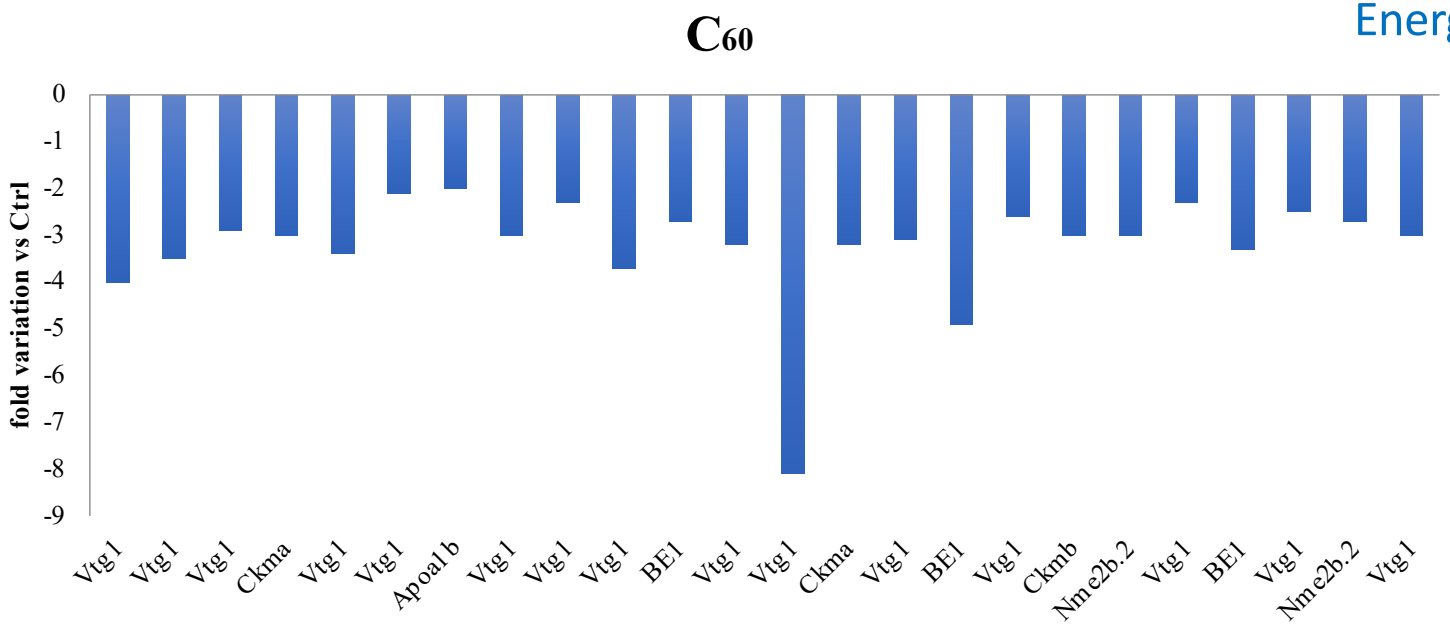
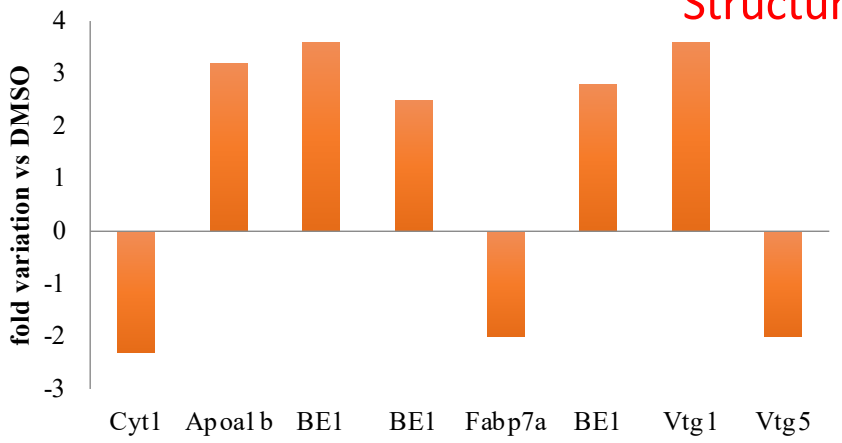
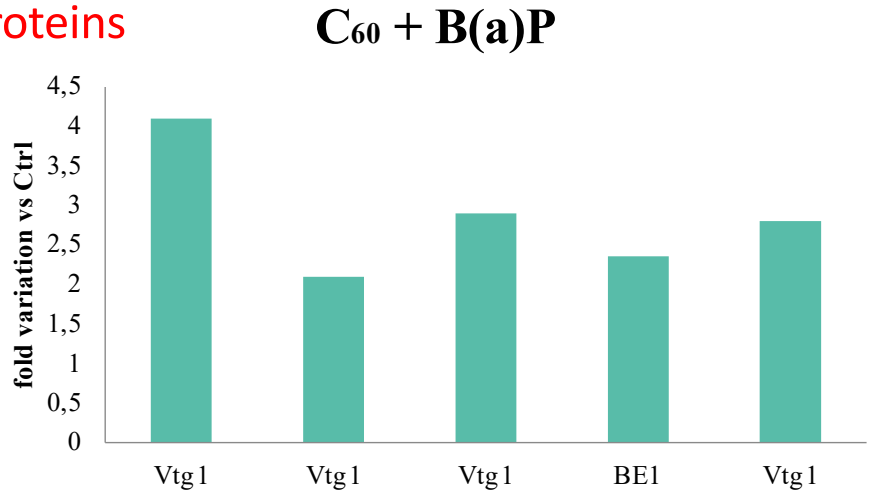
Effects on the proteome

Energetic metabolism

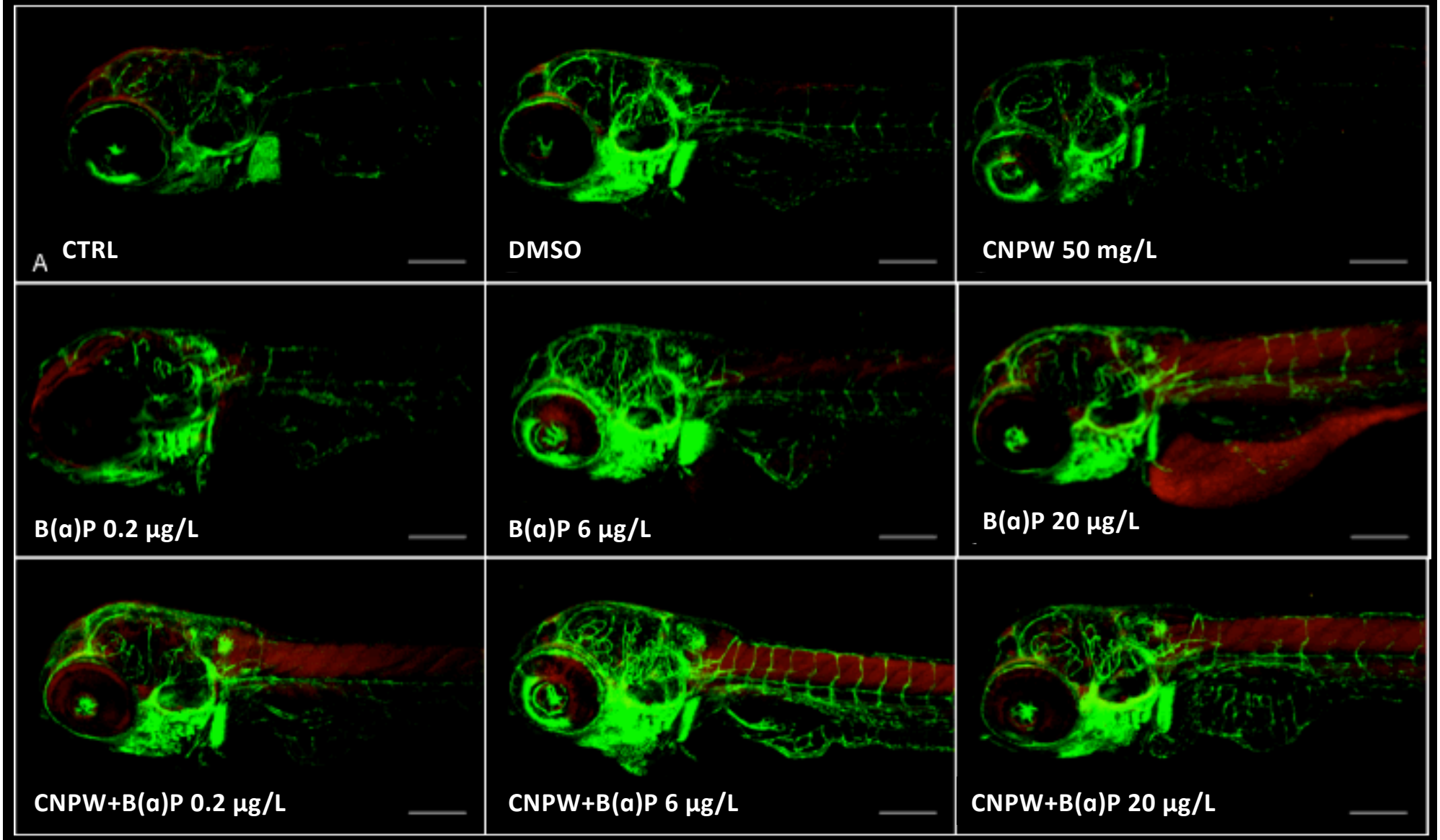


Stress proteins
Structural proteins





CNPW modifies B(α)P accumulation



Vascular system

B(α)P

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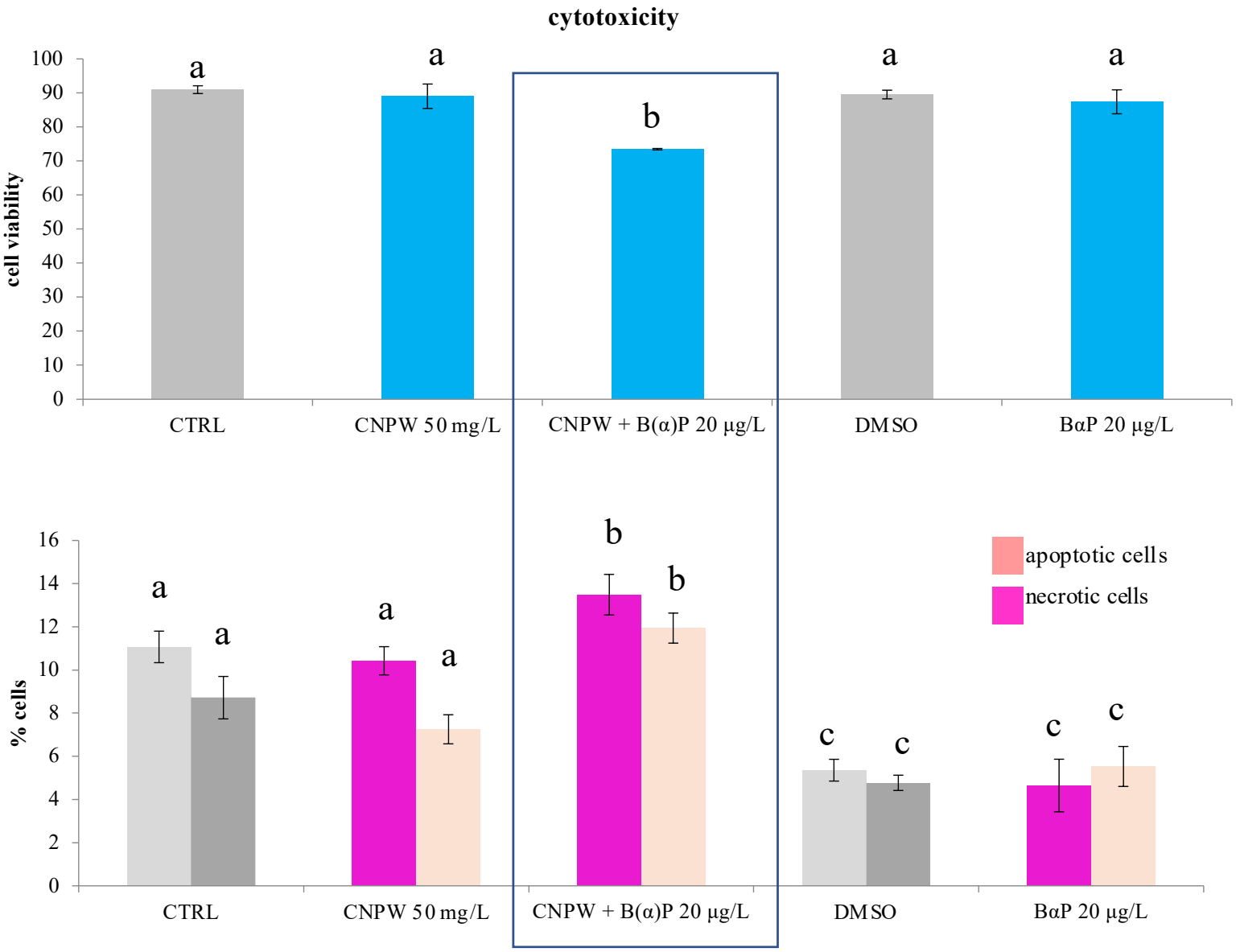
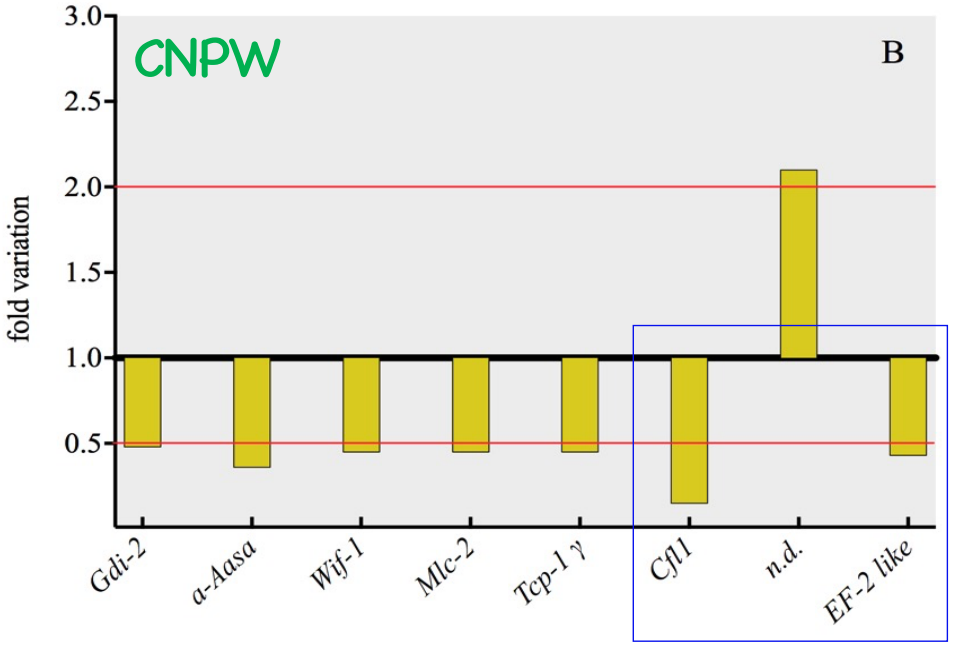
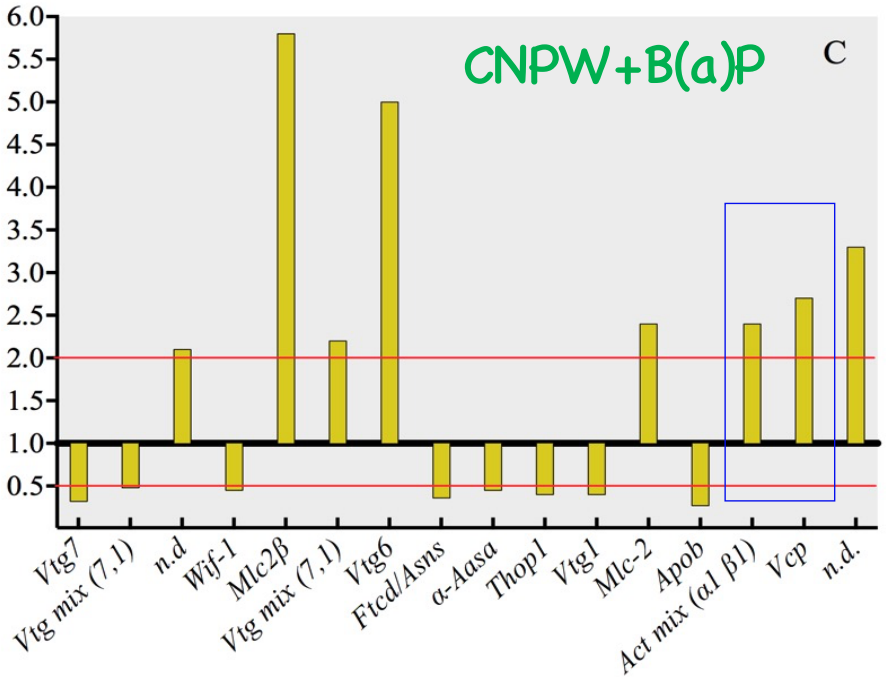
CNPW/B(α)P interaction affects cellular toxicity



Della Torre et al. 2017 Environ Sci-Nano

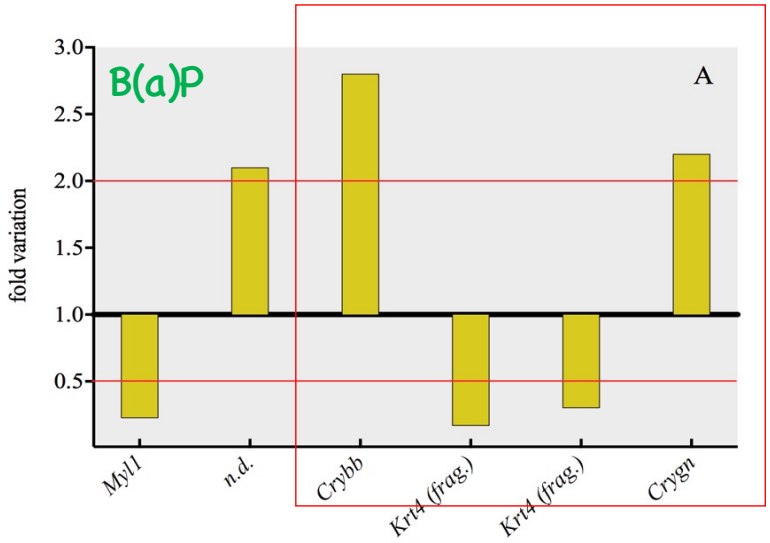
Effects on the proteome



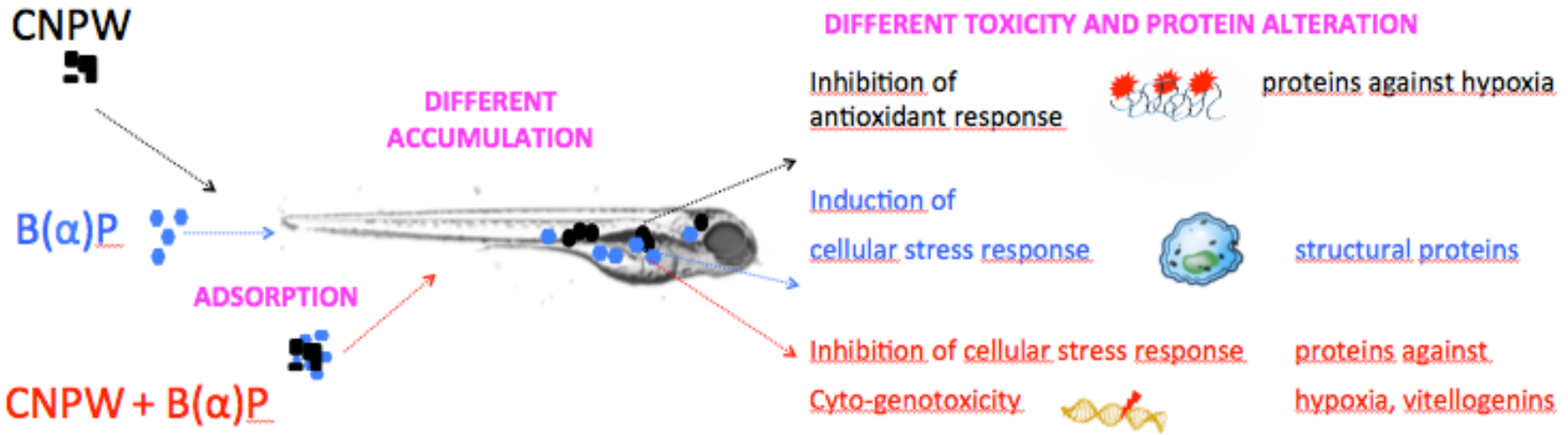


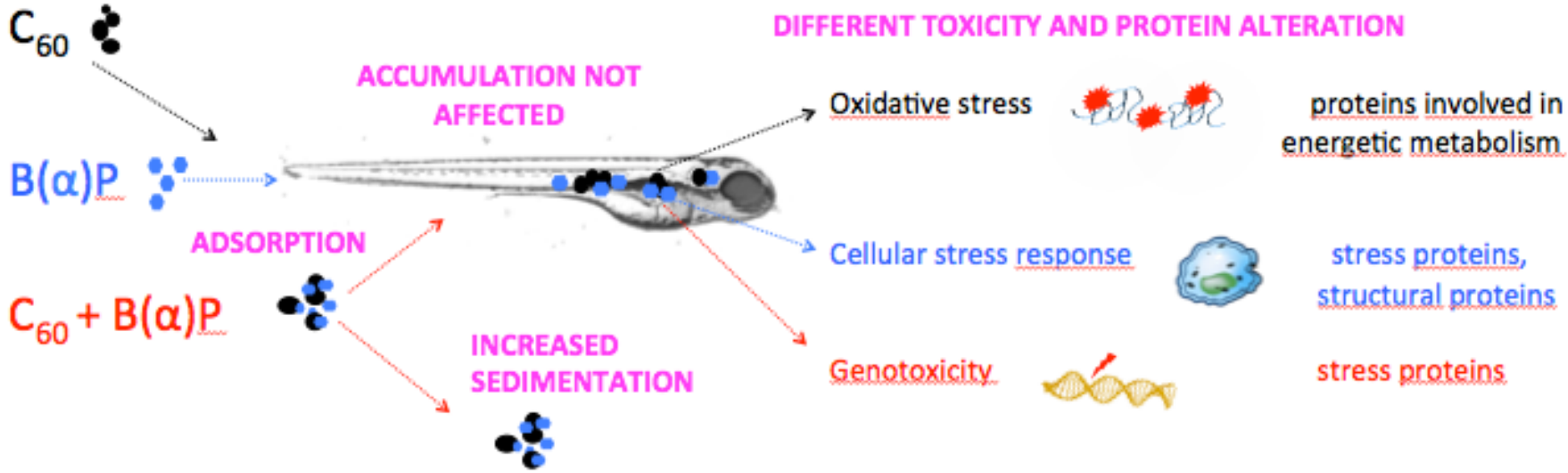
Homeostatic response to hypoxia

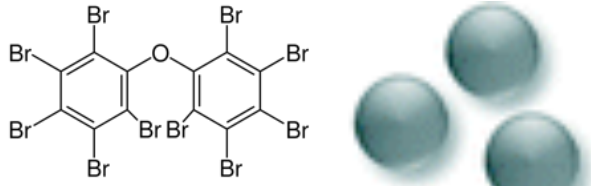
Structural proteins

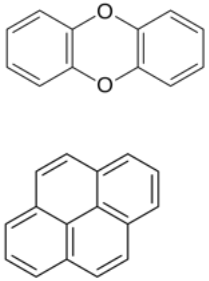


Binelli et al. 2017 Nanotoxicology


CNPW
B(α)P
ADSORPTION
CNPW + B(α)P
DIFFERENT ACCUMULATION
DIFFERENT TOXICITY AND PROTEIN ALTERATION
Inhibition of antioxidant response
proteins against hypoxia
Induction of cellular stress response
structural proteins
Inhibition of cellular stress response
proteins against hypoxia, vitellogenins
Cyto-genotoxicity

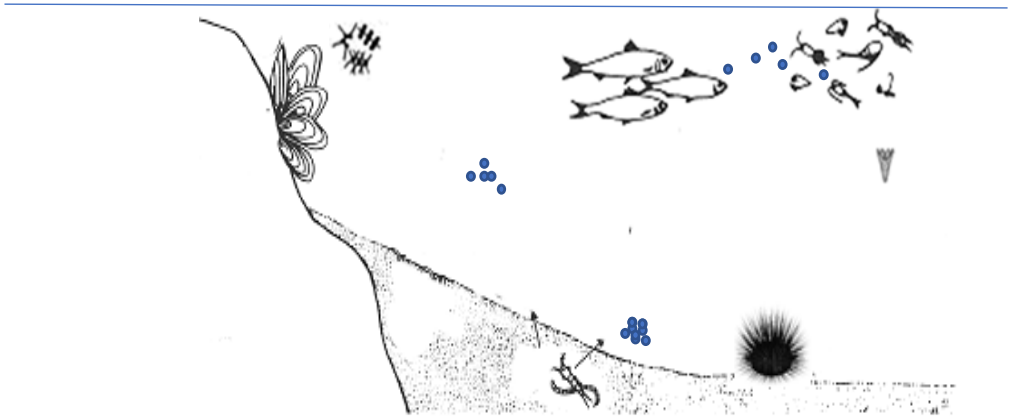

C60
B(α)P
ADSORPTION
C60 + B(α)P
ACCUMULATION NOT AFFECTED
INCREASED SEDIMENTATION
DIFFERENT TOXICITY AND PROTEIN ALTERATION
Oxidative stress
proteins involved in energetic metabolism
Cellular stress response
stress proteins, structural proteins
Genotoxicity
stress proteins

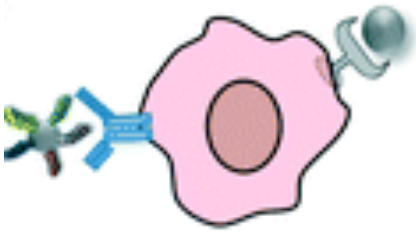




PHISICO-CHEMICAL PROPERTIES

BIOLOGICAL PROPERTIES





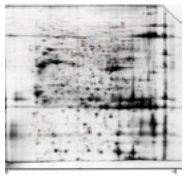
FATE/BIOAVAILABILITY

ECO-TOXICITY

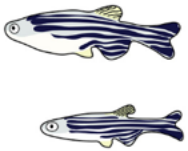
RISK ASSESSMENT

Research group

- Andrea Binelli
- Stefano Magni



- Luca Del Giacco
- Anna Ghilardi



- Nadia Santo
- Miriam Ascagni
- Laura Madaschi

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