(ARs) in the goldfish cardiac response to hypoxia. We first characterized the effects of β3-ARs stimulation in normoxic goldfish heart in terms of contractility and signal transduction. Then, we analysed their role in the hemodynamic response of the goldfish heart exposed to acute hypoxia. We found that goldfish cardiac β3-ARs expression is affected by hypoxia. Our data suggest that the activation of β3-ARs contributes to the increased contractility which characterizes the hypoxic goldfish heart.

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Sensitivity of carbonic anhydrase to metal exposure in the model organisms *Mytilus galloprovincialis*: *in vitro*, *in vivo* and in field approach

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Carbonic anhydrase (CA) is a ubiquitous metalloenzyme involved in a number of physiological processes. Its sensitivity to chemical pollutants has been recently recognized. The work was aimed to study the CA sensitivity to metal exposure in the digestive gland of the model organism *Mytilus galloprovincialis* under *in vitro*, *in vivo* and in field conditions, with reference to the functional involvement of CA in the lysosomal response to pollutant exposure. The study was carried out by immunofluorescence confocal microscopy, electrometric assay of CA activity, spectrofluorimetric and confocal analysis of the lysosomal system. Under *in vitro* exposure to $CdCl_2$ or $CuCl_2$, CA activity was dose dependently inhibited with an IC50 of 8.7 10^{-5}M for copper and 1.1 10^{-3} M for cadmium. On the other hand, under *in vivo* chronic exposure to $CuCl_2$ (0.3 10^{-6} M) or $CdCl_2$ (0.54 10^{-6} M) for 14 days, CA showed a significant upregulation, paralleled by the increased fluorescence of LysoSensor green charged cells, indicative of lysosome proliferation/increase in size. The metal induced lysosomal activation was prevented by the *in vivo* exposure to the specific CA inhibitor acetazolamide, demonstrating a key role of CA in the pollutant induced lysosomal activation. The response of CA upregulation paralleled by lysosomal activation was validated in field by an active biomonitoring approach in coastal marine sites interested by metal contamination. In conclusion, data showed the complexity and multi-aspect nature of the CA sensitivity to metals, which can be CA inhibitors at higher concentrations and modulator of CA expression at lower concentrations typical of chronic exposure. In this condition CA upregulation can be functional to the prolonged increased requirement of H^+ under lysosomal activation.

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Adverse effects of sunscreen agents on a marine flatfish: oxidative stress and energetic profiles in response to titanium dioxide nanoparticles and oxybenzone

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The increasing awareness of the negative effects of exposure to solar radiation has contributed to the growing use of sunscreens worldwide. These commercial products have in their composition both organic and inorganic UV filters, which have the ability to endure protection against radiation. The presence of UV filter ingredients has been detected in marine waters with potential toxic consequences for the marine biota. Hence, the main goal of this study was to evaluate the oxidative stress and metabolic response profiles induced by the most commonly used UV filters (an inorganic: titanium dioxide nanoparticles - TiO_2 Np and an organic one: oxybenzone - BP-3), on the marine flatfish *Scophthalmus maximus*. Fish were intraperitoneally injected with 3.0 $\mu g.g^{-1}$ per body weight of each compound and their mixture, and analysed after 72 and 168 h. Liver, kidney and intestine were sampled to assess the antioxidant profiles (CAT, SOD, GPx, GR activities and GSHt content) and membrane damage (LPO). Potential alterations of the energetic processes were also evaluated by the activities of IDH (it can also provide information regarding oxidative stress defences) and LDH activities in the liver. The oxidative stress profile suggested that the individual effect of TiO_2 Np or BP-3 was changed when in mixture in most organs, but without enduring membrane damage. The intestine was the most susceptible organ to the effects of the UV filters while kidney seemed not to be a target for these compounds. The alteration of the metabolic responses was only observed after 168 h, suggesting that the mixture may impair the energetic processes of fish. Thus, the combined use of TiO_2 Np and BP-3 UV filters in sunscreens, and the subsequent co-occurrence in marine systems, might adversely affect fish physiology

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