Lipofuscin, lipofuscin-like pigments and autofluorescence

This paper provides a syntethic overview on lipofuscin and lipofuscin-like substances, with particlar reference to their biological significance as well as to their cellular origin and pathophysiological role. Special emphasis is also placed on the mutual relationships between lipofuscin and lipofuscin-like lipopigments on one side, and cell autofluorescence (AF) on the other. In this respect, although the first microscopic evidence of AF was reported over 100 years ago, the interest of the scientific community in this widespread biological phenomenon continues to be remarkable. As a matter of fact, the frequent presence of endogenous biomolecules with a fluorophore-like behaviour in organisms and living systems across the entire life kingdom makes AF a commonly occurring phenomenon.

Several endogenous fluorophores - such as porphyrins, a variety of vitamins (vitamin A, riboflavin, thiamine), structural proteins, lipofuscin and ceroid pigments, along with others - may be responsble for cell and tissue AF. Noteworthy, intracellular AF has been recently characterized as a selective biomarker for epithelial cancer stem cells (CSCs), with such epithelial CSC-specific AF being also accompanied by a strongly invasive and chemoresistant cell phenotype.

The formation of lipofuscin and lipofuscin-like compounds is known to take place under a variety of pathophysiological conditions, such as oxidative stress and ageing, “two sides of the same coin” which are essentially characterized by a progressive unbalance between protein damage and cleaance, leading at its turn to an increased protein homeostasis disturbance, with accumulation of oxidized proteins’ aggregates and, subsequently, of highly-cross linked materials such as lipofuscin and lipofuscin-like lipopigments, affecting cell viability.

Furthermore, as far as the biological effects exerted by lipofuscin and lipofuscin-like lipopigments in host cells are concerned, they have not been precisely determined, thus far. Nevertheless, beside being a powerful oxidants’ source, lipofuscin has also been shown to incorporate iron in a redox-active fashion and to induce apoptosis, with the degree of lipofuscin-driven cell damage and cytotoxicity appearing to be tightly related to the iron concentration present in lipofuscin itself.

In conclusion, as clearly exemplified among others by the recent characterization of AF as a biomarker for epithelial CSCs, few doubts exist about the enormous possibilities offered by the increasingly sophisticated biomolecular and microscopic techniques for a better characterization of autofluorescent lipofuscin and lipofuscin-like lipopigments, with special reference to their biologcal significance, cell origin and fate, along with their pathophysiological role in health, ageing and disease.

Publication

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Di Guardo G.
J Eur J Histochem. 2015 Feb 6