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Assessing Melanin Capabilities in Radiation Shielding and Radioadaptation

There is a need in creating efficient and light weight radioprotectors which would protect against both sparsely and densely ionizing radiation for use in radiation therapy, nuclear industry, protection of military personnel and in space exploration. The presence of melanin pigment imparts a selective advantage to fungi promoting survival and cellular fitness. Selective growth of melanized fungi in extreme locations with high levels of ionizing radiation such as the damaged nuclear reactor at Chernobyl and the Antarctic deserts, demonstrates their survival advantage. Following exposure to ionizing radiation melanized fungi demonstrate various biological responses including improved survival, radiostimulation, radiotropism, and radioadaptation. Melanin' s unique structure enables it to interact with ionizing radiation providing several levels of protection and advantage. First, melanin provides physical shielding, which we have demonstrated in Cryptococcus neoformans where melanized fungal cells showed improved structural cellular integrity against alpha particle and deuteron particle bombardment than that of a non-melanized control. This physical shielding reduces the relative biological effectiveness of the ionizing radiation. Second, melanin acts as chemical shield through its radical scavenging activities. Third, melanin's electrochemical properties change in response to irradiation. The ability of melanin to interact and respond to ionizing radiation results in improved survival and health of organisms, suggesting a melanin-dependant mechanism whereby radiation is transduced into other usable and advantageous forms of energy for the organism, or is involved in cellular communication. We have shown in a recent publication that melanized C. neoformans is more resistant to alpha particles than gamma rays at the same radiation dose which suggests that melanized fungi have the potential capability to differentiate between different types of radiation sources. By subjecting the melanized fungi C. neoformans and Wangiella dermatitidis to long term exposure to various radionuclides we have developed radiation adapted strains in the lab that demonstrate radiostimulatory and radiotropic responses. We will use these radiation adapted strains to determine if they are capable of differentiating between the types of radiation. In developing these strains we hypothesize that they could be utilized to identify sources of ionizing radiation based on the biological response of the laboratory adapted strains. The data generated here will provide insights for future research to design effective biological system for detection of even minute levels of nuclear fallout. Additionally we hope to advance our understanding of the relationship between melanin, fungi and resistance to ionizing radiation providing us new knowledge of radiation shielding, quenching, energy generation, and cellular communication.

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