Studies of fungi provide new knowledge of harmful mutations in cells

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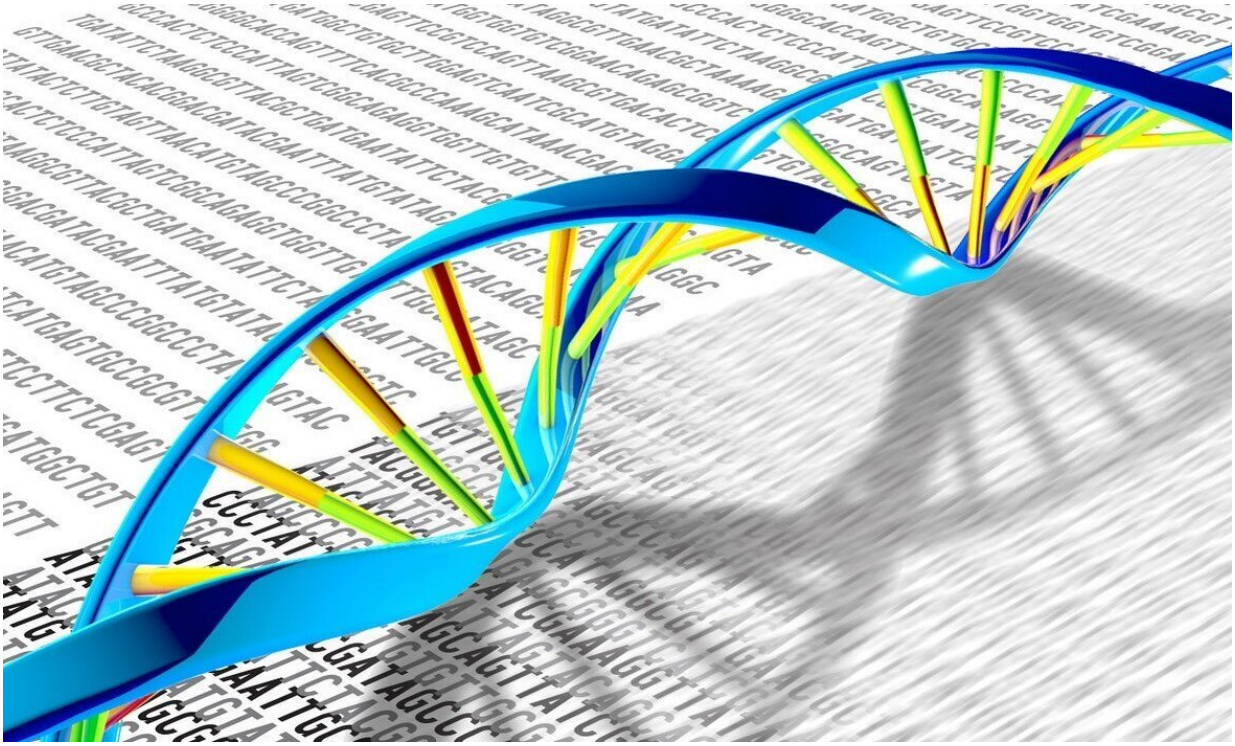

DNA, which has a double-helix structure, can have many genetic mutations and variations. Credit: NIH

Long-lived mushrooms that grow in 'fairy rings' accumulate surprisingly few mutations over time. This finding indicates that their protection against harmful mutations is well developed. The results, to be published in the esteemed journal *Current Biology*, are interesting in terms of both

medicine and evolutionary biology.

In all living creatures, every cell contains DNA, which encodes the functions that the cell can perform. Changes in DNA, 'mutations,' may cause loss of cell function, boosting the risk of disease. It is therefore important for the DNA to be kept intact over time. Whenever a cell divides, there is an increased risk of new mutations. Thus, organisms that are long-lived, and in which every cell can contribute DNA to the next generation, are particularly vulnerable to harmful mutations. In this study, researchers examined the speed and pattern of mutations in a species of long-lived fungus (*Marasmius oreades*, the Scotch bonnet or 'fairy ring mushroom') that forms 'fairy rings.'

Fairy rings can be found on lawns or in woodlands and forests. A darker circle in the vegetation under the mushrooms, or a circle of dead grass during dry periods, is sometimes distinguishable. Historically, fairy rings have been associated with various supernatural notions, such as traces of witches' cauldrons, dancing elves or other magical creatures. Nowadays, we know that a fairy ring is formed by the circular underground mycelium, the main body of a fungus (composed of a tangled web of threads called hyphae), which grows radially outwards from a starting point while, over time, dying away in the middle. Just as in most other species of fungi, every cell of the mycelium can form a fruiting body and give rise to a new generation of fungi.

In the current study, the researchers used fairy rings of *Marasmius oreades*, combined with whole genome DNA sequencing, to study mutations. The number of mutations proved to be strikingly small given the number of cell divisions that had taken place.

"In studying mutations, you often use cell lines at the lab, which isn't practical over long periods. In fairy rings, we can at one time-point study the emergence and accumulation of mutations over many years, and also

in the organism's natural environment. Interestingly, we found far fewer mutations than we expected," says Markus Hiltunen, doctoral student and lead author of the study.

The results indicate that such long-lived fungi have a capacity to protect themselves against an accumulation of harmful mutations. In-depth study of the cell processes in these fungi can therefore provide important new knowledge about the challenges that need resolving to make their longevity attainable.

"The mechanism facilitating this protection is currently unknown, but leading candidates are extremely effective DNA repair systems or asymmetric DNA division during cell division, where mutated DNA may be left behind as the fungus grows outward. But this needs to be clarified in new studies," says Hanna Johannesson, who heads the research group at Uppsala University.

The study boosts knowledge about the challenges and solutions that are necessary for individuals to grow old and reproduce at an advanced age. This is relevant in areas including evolutionary biology and cancer research.

More information: "Maintenance of high genome integrity over vegetative growth in the fairy-ring mushroom Marasmius oreades", *Current Biology* (2019). DOI: 10.1016/j.cub.2019.07.025

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