



Sequencing the Malassezia Genome

After discovering that *Malassezia globosa* was a key trigger of dandruff, P&G Beauty external genetics and mycology scientists set to work sequencing the entire fungus genome. The goal: to further understand the fungus and how it works, therefore better understanding how to target and change the way the fungus behaves. Before this study, little was known about the *Malassezia* species at the molecular level. Due to the earlier use of less-accurate culture-based technologies, scientists incorrectly assumed for years that dandruff and other skin conditions were caused by a different type of the fungus (*Malassezia furfur*). The complete genome sequencing was made possible by P&G Beauty's use of molecular science and bioinformatics.

Sequencing Step-by-Step

1. Scientist cultivated 10 liters of *M. globosa*.
 - a. Ten liters of fungus is equal to the amount of fungus that would be found on the heads of 10 million people, or the entire population of London.
 - b. Due to the temperamental nature of the fungus, *M. globosa* was successfully cultured only by keeping it at a very specific temperature, and feeding it certain brands of olive oil and ox bile.
2. In order to break open *M. globosa* without destroying the DNA, the cultivated fungi were frozen in liquid nitrogen.
3. The frozen *M. globosa* were cracked; DNA was extracted in one piece and then spliced into 76,900 plasmids.
 - a. Using these plasmids, scientists integrated 153,600 random sequencing reactions.
4. Finally, scientists identified the exact coding of each part and re-assembled the pieces to complete the sequence.

Interesting Learnings

- The *M. globosa* genome is comprised of just 9 million base pairs consisting of about 4,285 protein coding genes. It is among the smallest sequenced free-living fungal genome.
- The genome sequencing was performed on *M. globosa* type strain CBS 7966, the most commonly found strain of *M. globosa*.
- *M. globosa* has very few repeated elements, which makes it one of the most efficient of any fungal organism identified to date.
- *M. globosa* lacks the ability to synthesize fatty acids, making it highly adaptive and niche dependent. It is commonly found on the scalp, back, face and chest, areas where the highest levels of sebum is produced.
- *M. globosa* is capable of excreting over 50 different enzymes that help digest and break down materials such as hair and scalp.
- The research suggested that *M. globosa* is capable of mating, a key consideration in the organism's ability to change and adapt in the future.

Lead Investigators

- Thomas L. Dawson, Jr. – Scalp and Hair Biologist, P&G Beauty Co.
- Charles W. Saunders – Fungal Biochemist, Fungal Geneticist, P&G Global Biotechnology
- Jun Xu – Computational Biologist, Bioinformaticist, P&G Global Biotechnology
- Raymond A. Grant – Proteomics Specialist, P&G Global Biotechnology

Lead Academic Collaborators

- Teun Boekhout – Fungal Phylogenist, Fungal Biologist, Evolutionary Biologist, CBS-Fungal Biodiversity Centre
- James W. Kronstad – Fungal Biologist, University of British Columbia

Corporate Collaborators

- Integrated Genomics, Chicago, Ill, Genomic Sequencing
- Agencourt, Beverly, Mass, cDNA Sequencing