

# Preventative medicine: understanding the cause of gum disease with AI

STFC Hartree® Centre and IBM collaborated with Salient Bio to develop a machine learning-enabled pipeline to categorise the oral microbiome and to further our understanding of gum disease through the Hartree National Centre of Digital Innovation (HNCDI).

## Challenge

Gum disease (periodontitis) is one of the most widespread chronic conditions worldwide, but understanding its molecular mechanisms remains a challenge. The disease is driven not by any single 'bad bacteria' but by a breakdown in the balance of the entire oral ecosystem. Most existing research tools used to understand this condition lack predictive power; they take the approach of checking whether specific harmful bacteria are present or absent. This overlooks the interactions between bacteria and how these dynamics impact the oral microbiome. There is a clear need for diagnostic approaches beyond traditional techniques which consider the interactions, dependencies and competitive relationships among bacteria that collectively tip the balance towards health or disease.

## Approach

Researchers analysed genetic sequencing data from the oral microbiomes of around 600 individuals, collected by Salient Bio and their dental partner. The data collection also involved extensive patient metadata, which captured lifestyle factors. This enabled analysis of the relationship between an unhealthy microbiome and an individual's behaviour and environment. Inferring co-occurrence network maps from this data revealed disease-specific community modules; tightly connected clusters of bacteria that behave as functional units and are distinctive to either healthy or diseased states. By combining network analysis with explainable machine learning, the researchers distilled the complexity of the full microbiome down to a focused panel of just 13 key bacterial species. This compact set achieved strong diagnostic accuracy, comparable to models using hundreds of features.

**“Collaborating with the Hartree Centre and IBM gave us access to ML expertise and analytical frameworks that accelerated what we could achieve as a team.”**

**Tom Sewell**  
Salient Bio



Credit: Adobe Stock

## Benefits

The accurate and deep biological insight uncovered with this approach reveals the ecological mechanisms underpinning the cause of gum disease. By being able to identify at-risk individuals before clinical symptoms become severe, novel, targeted therapies could be used to preventatively treat individuals, reducing overall cases of gum disease and reducing our reliance on broad-spectrum antibiotics. This framework is not just limited to gum disease, it establishes a reusable blueprint for microbiome-based diagnostics and therefore could be used to support research that deepens our understanding of human microbiomes and contributes to the development of novel therapies.

## At a glance

- Transferable framework can be applied to other microbiome-based diagnostics
- Deepened disease insight which can inform novel therapy development, reducing our antibiotic reliance
- More accurate disease screening, which could provide a foundation for flagging at-risk individuals
- Framework supports personalised view of diseases by incorporating lifestyle and demographic factors

## The programme

The Hartree National Centre for Digital Innovation is a collaboration between the Hartree Centre and IBM which offers a safe and supportive environment for UK organisations to explore the latest digital technologies and skills, develop proofs-of-concept and apply them to industry and public sector challenges.

## Who we are

The Hartree Centre was created by UK Government to help businesses and public sector organisations accelerate the adoption of high performance computing (HPC), big data analytics, artificial intelligence (AI) and quantum technologies. We play a key role in realising UK Government's Industrial Strategy by stimulating applied digital research and innovation, creating value for the organisations we work with and generating economic and societal impact for the UK. We are proud to be part of UK Research and Innovation.

## What we do

- Boost productivity and innovation for industry
- Offer training and skills development
- Provide insights into future technologies
- Give tailored business development support

