



spora





A close-up photograph of a highly textured, orange-colored surface, possibly a biological specimen or a mineral sample. The texture is granular and uneven, with some darker, greyish-brown patches interspersed among the orange areas. The lighting is warm, highlighting the intricate details of the surface.

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## *Neurospora intermedia* from a traditional fermented food enables waste-to-food conversion

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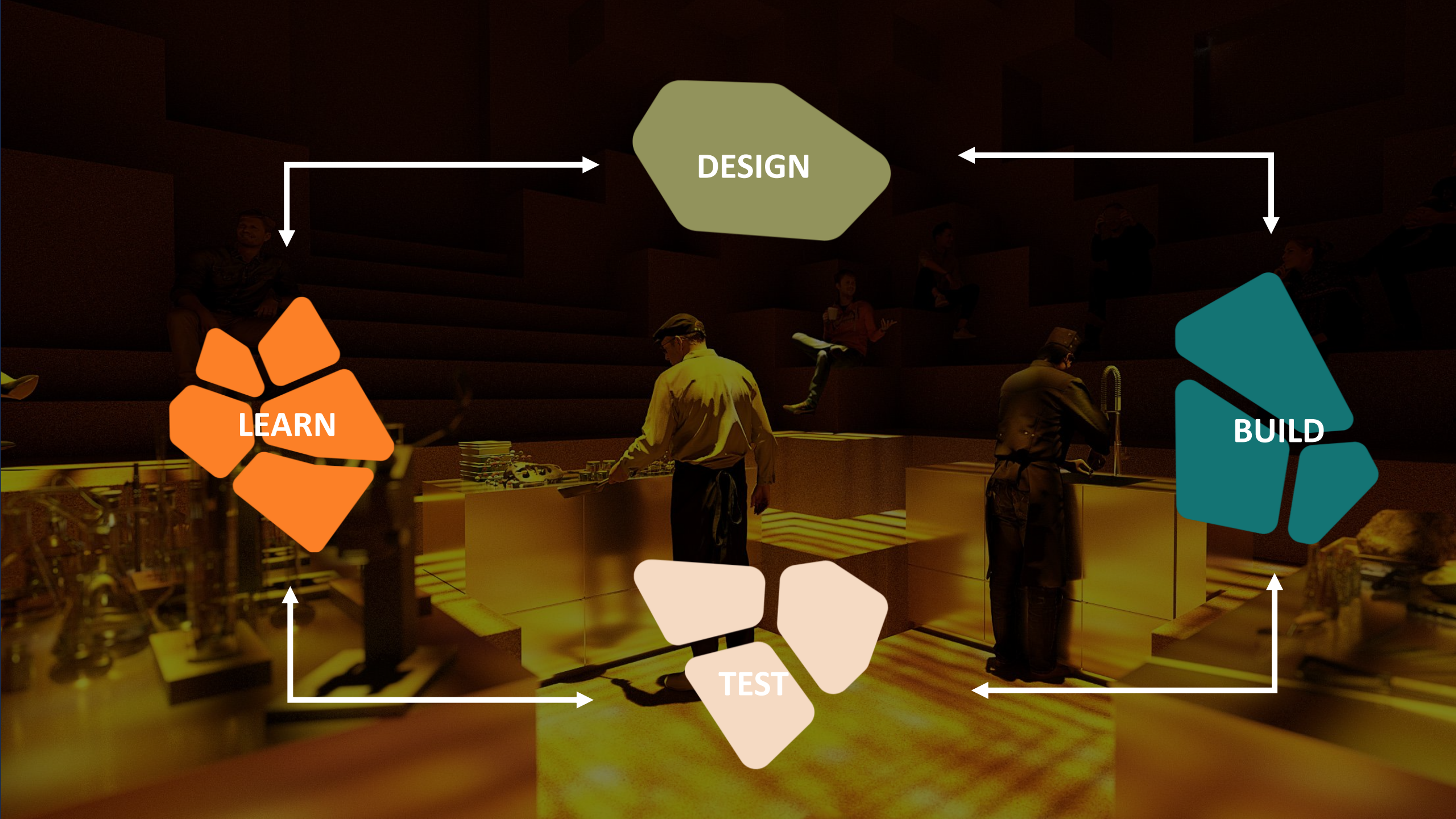
Fungal fermentation of food and agricultural by-products holds promise for improving food sustainability and security. However, the molecular basis of fungal waste-to-food upcycling remains poorly understood. Here we use a multi-omics approach to characterize oncom, a fermented food traditionally produced from soymilk by-products in Java, Indonesia. Metagenomic sequencing of samples from small-scale producers in Western Java indicated that the fungus *Neurospora intermedia* dominates oncom. Further transcriptomic, metabolomic and phylogenomic analysis revealed that oncom-derived *N. intermedia* utilizes pectin and cellulose degradation during fermentation and belongs to a genetically distinct subpopulation associated with human-generated by-products. Finally, we found that *N. intermedia* grew on diverse by-products such as fruit and vegetable pomace and plant-based milk waste, did not encode mycotoxins, and could create foods that were positively perceived by consumers outside Indonesia. These results showcase the traditional significance and future potential of fungal fermentation for creating delicious and nutritious foods from readily available by-products.



Craftsmanship — Hands-on experimentation —  
Creativity-based  
Analytical by sensory: **Taste, Smell, Touch, Look**



Scientific practice — Systematic investigation —  
Evidence-based.  
Analytical precision: **Data driven**

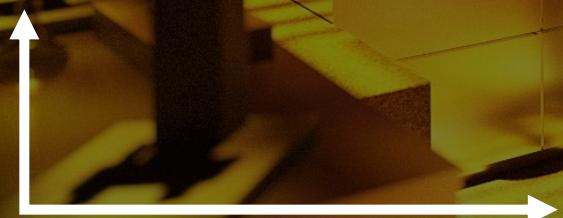
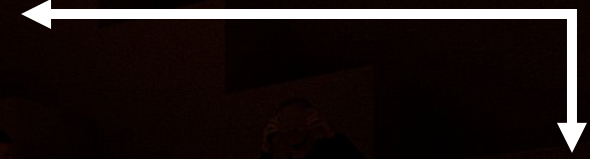


DESIGN

LEARN

BUILD

TEST















# GUT MICROBIOME HEALTH



# RAPESEED PRESS CAKE

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The background is a dark teal color with a repeating pattern of white-outlined trees and palm trees. A thick, dark teal river flows from the top right towards the center. On the right bank of the river, there is a white building with a blue roof and a large arched entrance, and a small blue boat. In the center, a field of tall green crops is shown. A blue tractor is pulling a blue harrow or similar agricultural machine through the field. The text 'Turning CO2 into foods of the future' is centered in a white, bold, sans-serif font within a dark teal rectangular box.

# Turning CO<sub>2</sub> into foods of the future

spora



novonosis



Northwestern  
University

spora



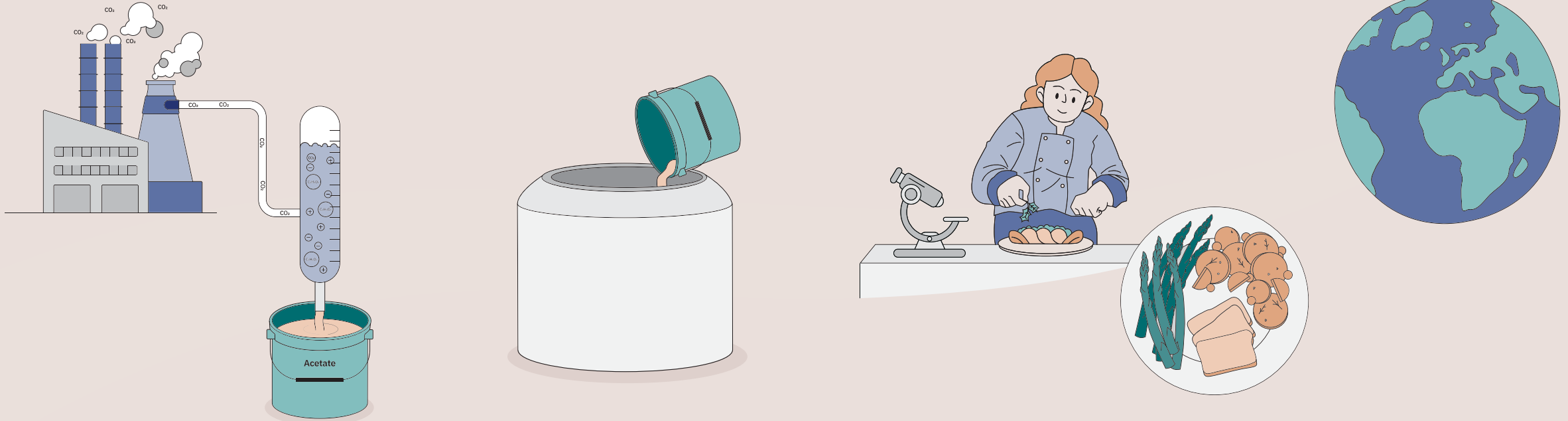
TOPSOE

Funded by:

Gates Foundation

novo nordisk  
**foundation**

# CONVERTING CO<sub>2</sub> INTO PROTEIN



> Through the use of fermentation, it is possible to produce edible proteins. Instead of relying on sugars, the microbes that drive the fermentation can use acetate, a simple molecule, as fuel. Acetate itself can be produced cheaply and sustainably from captured CO<sub>2</sub> using electrochemical methods. In this way, greenhouse gases can be transformed into valuable food resources.

> Acetate can be used directly in fermentation for protein production and thus completely eliminate the need for sugar in fermentation.

> Protein produced through acetate fermentation can serve directly as a nutritious source, and with culinary and scientific expertise, it is developed into healthy and delicious food solutions.

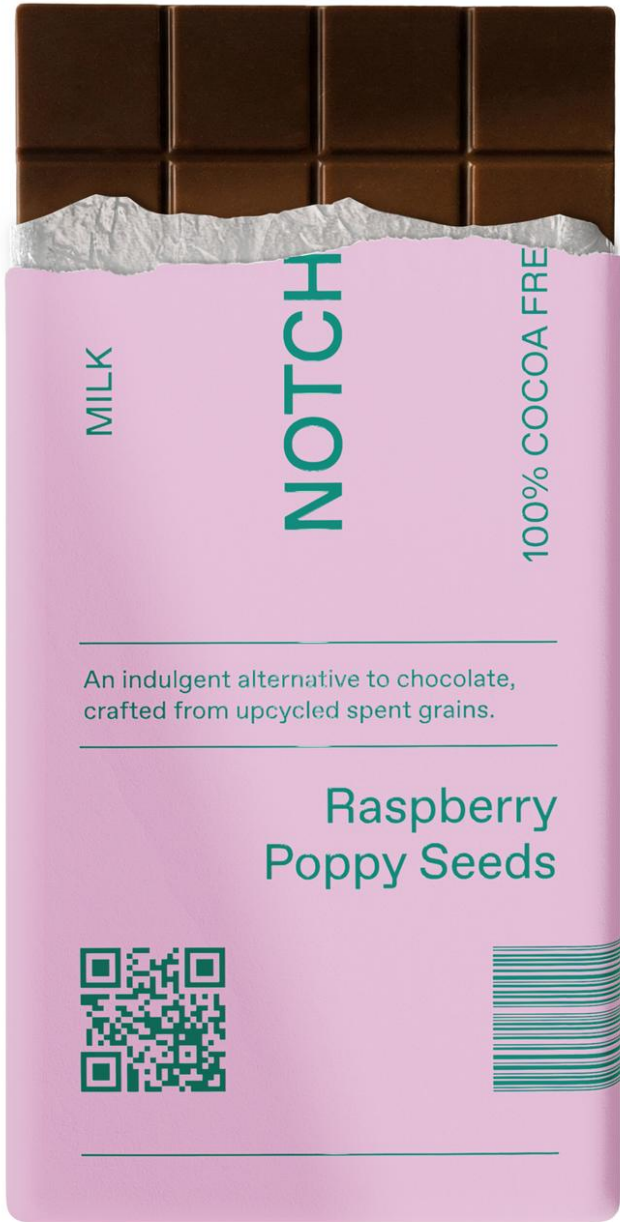
> This approach has the potential to provide protein for more than one billion people annually, offering stable, delicious nutrition while reducing CO<sub>2</sub> emissions and land use.

A close-up photograph of a person's hand holding a large quantity of brown, crumbly spent grain. The background is a blurred field of similar grain. The image is framed by white, stylized outlines of grain shapes on the left and right sides.

**BREWERS SPENT GRAIN**



This







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