PET- COW

André & Adrian *(+ Maren)*

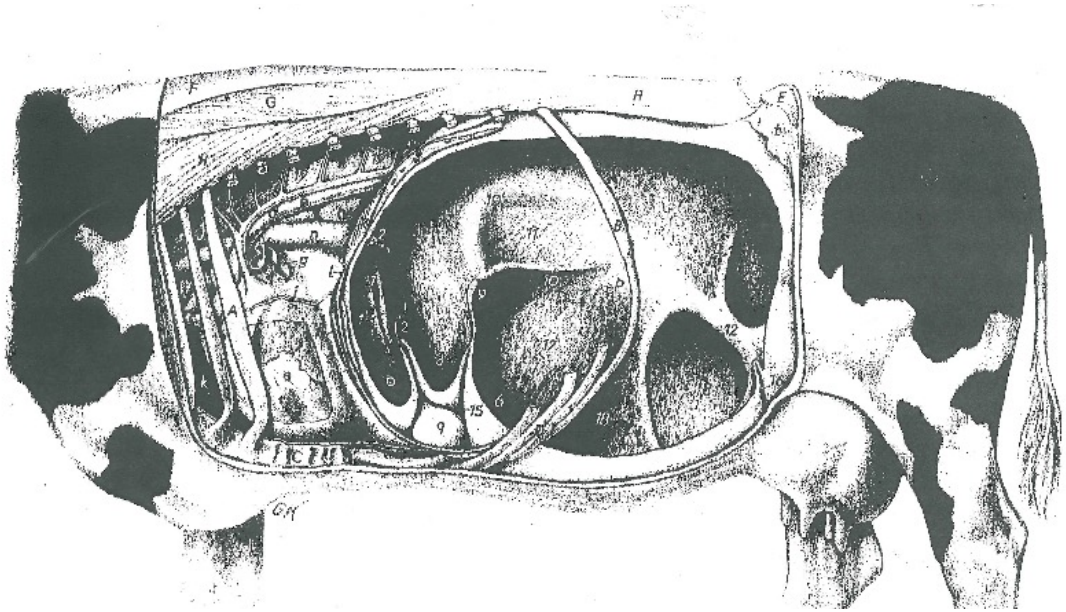
Problem formulation – In Europe, widespread consumption of plastic has resulted in 25.8 million tons of waste in our terrestrial and marine environment, with polyesters accounting for approximately 15%.

Present Issues – Today, we recycle plastics by simply burying or burning them – BUT this is not proper recycling. Moreover, plastics melt at different temperatures (yoghurt pots 140-160 ^{o}C - plastic bottles 240-260 ^{o}C)

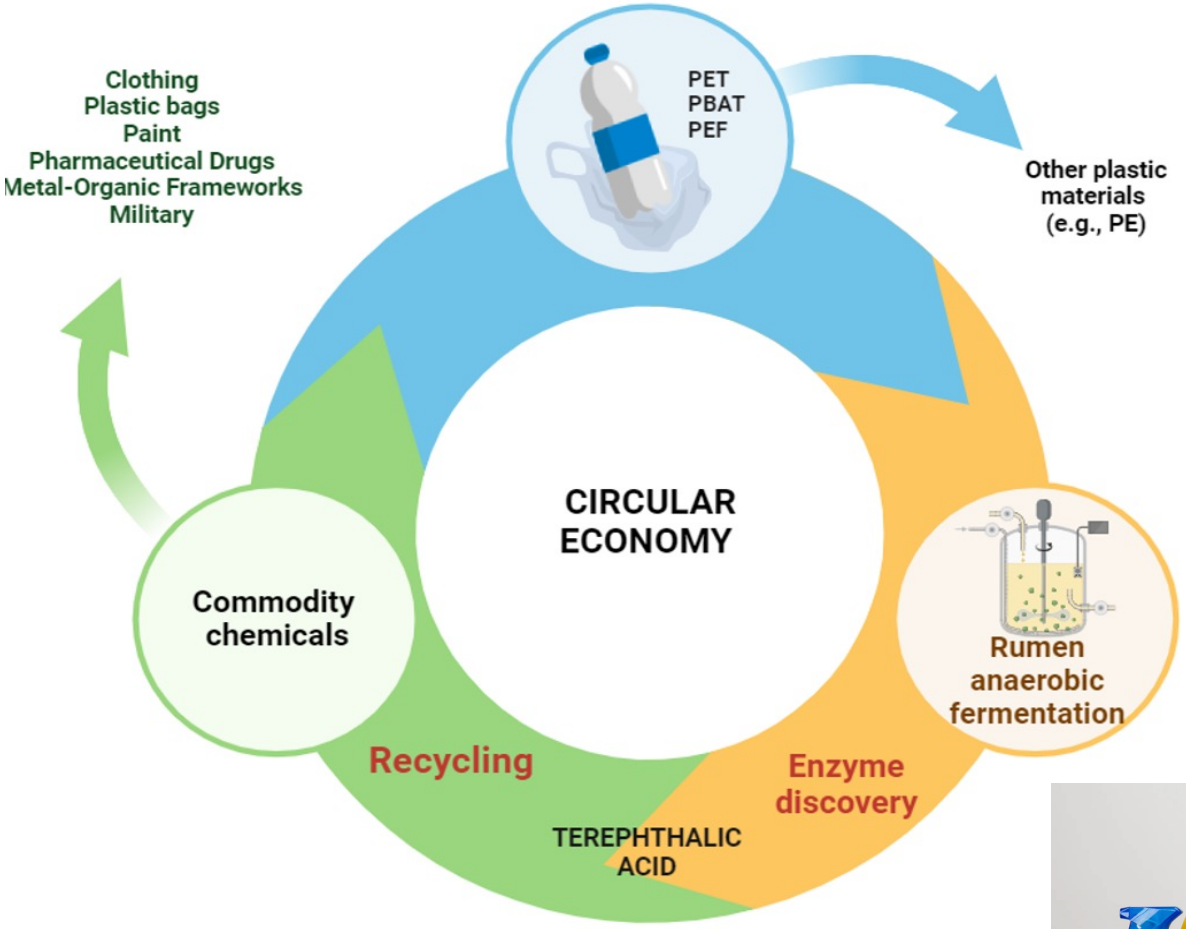
- Plastics are currently chopped into small pieces – but since different plastics melt at different temperatures, some plastics melt and are burnt around others, impairing the recycling process's efficiency.

- Current recycling of plastic only truly returns 23% of the plastics that are collected and sorted, back to become new plastic items.

- Every time plastics are reused in the current process their quality is affected.

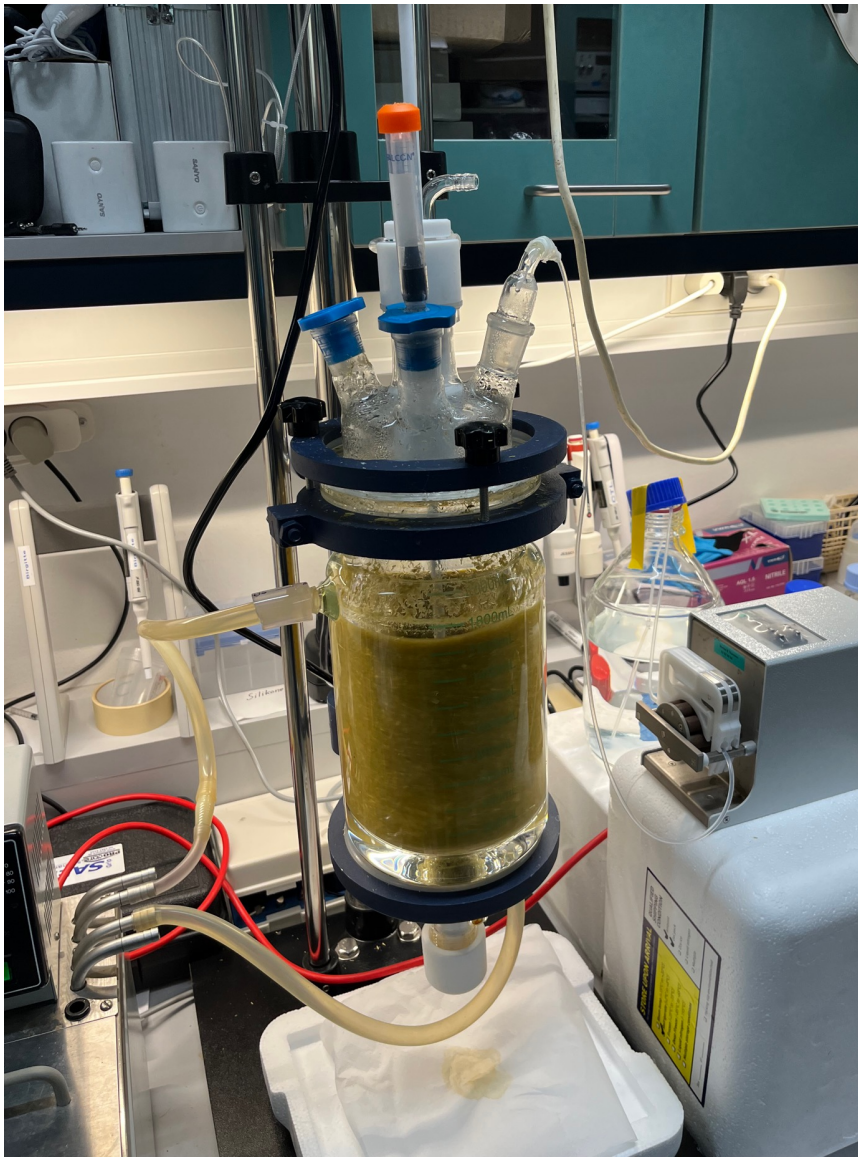


Solution – Take advantage of the natural enzymatic capabilities of microbes found in the pre-stomachs of cows.



poly(ethylene terephthalate)- PET
poly(butylene adipate-coterephthalate) – PBAT
poly(ethylene furanoate) – PEF

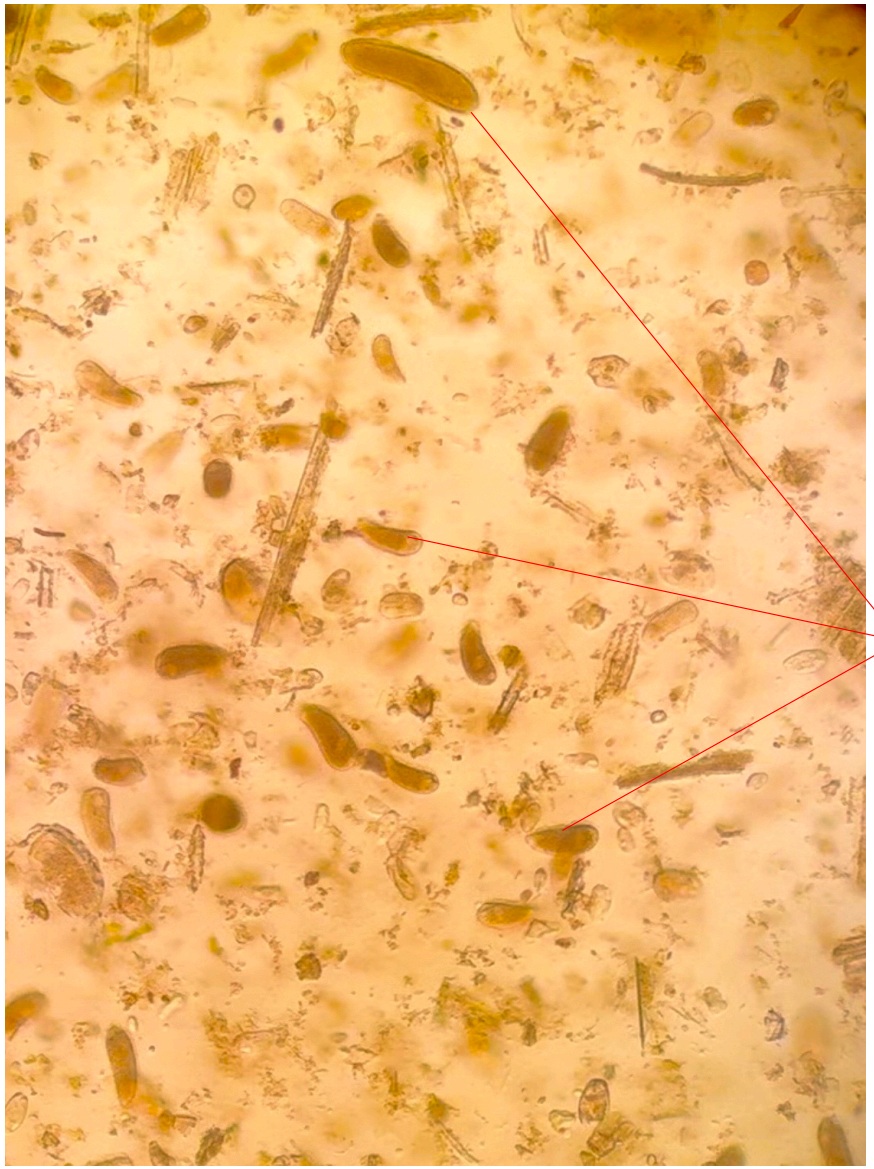
Motorized stirrer



Saliva pump

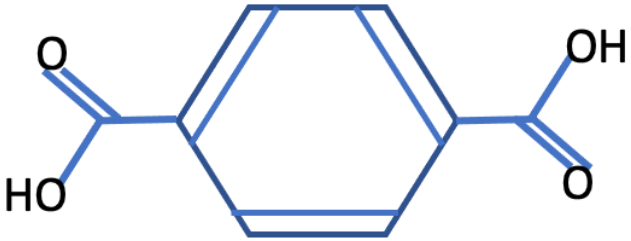
Waterbath

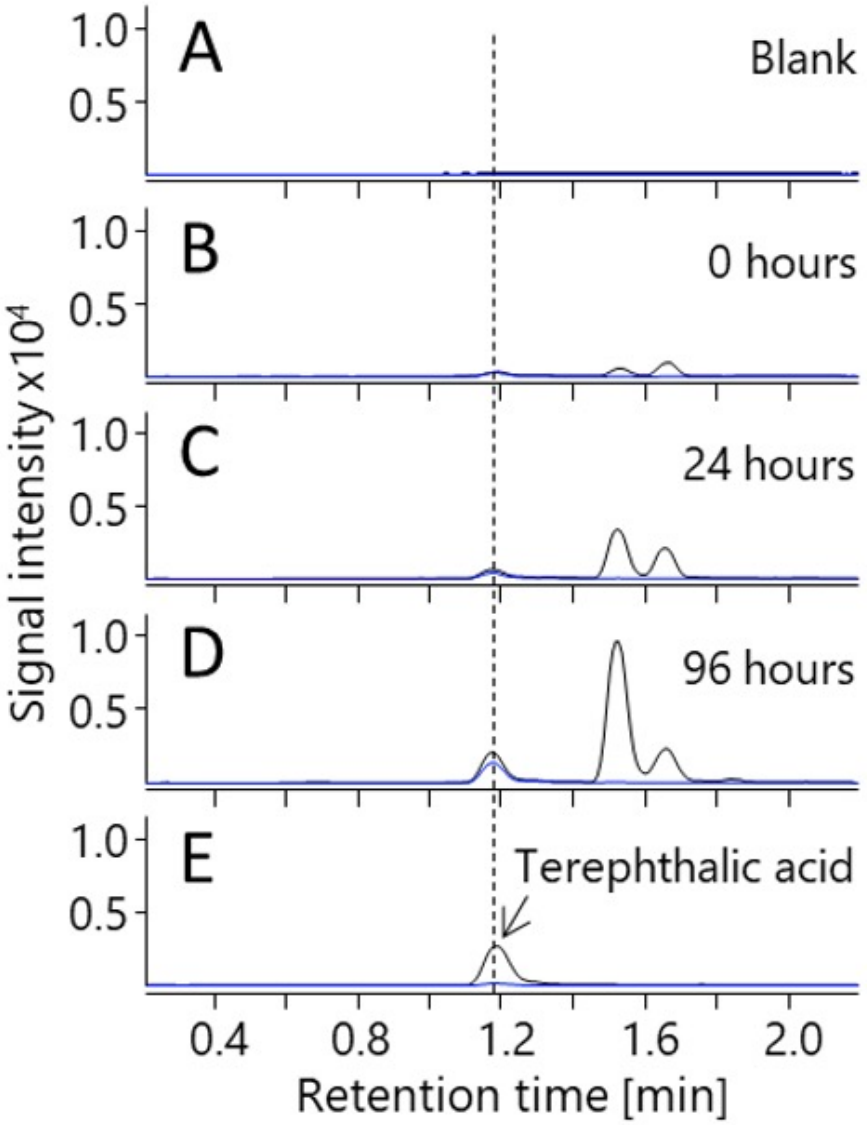
Fermentation plant ”Maren”



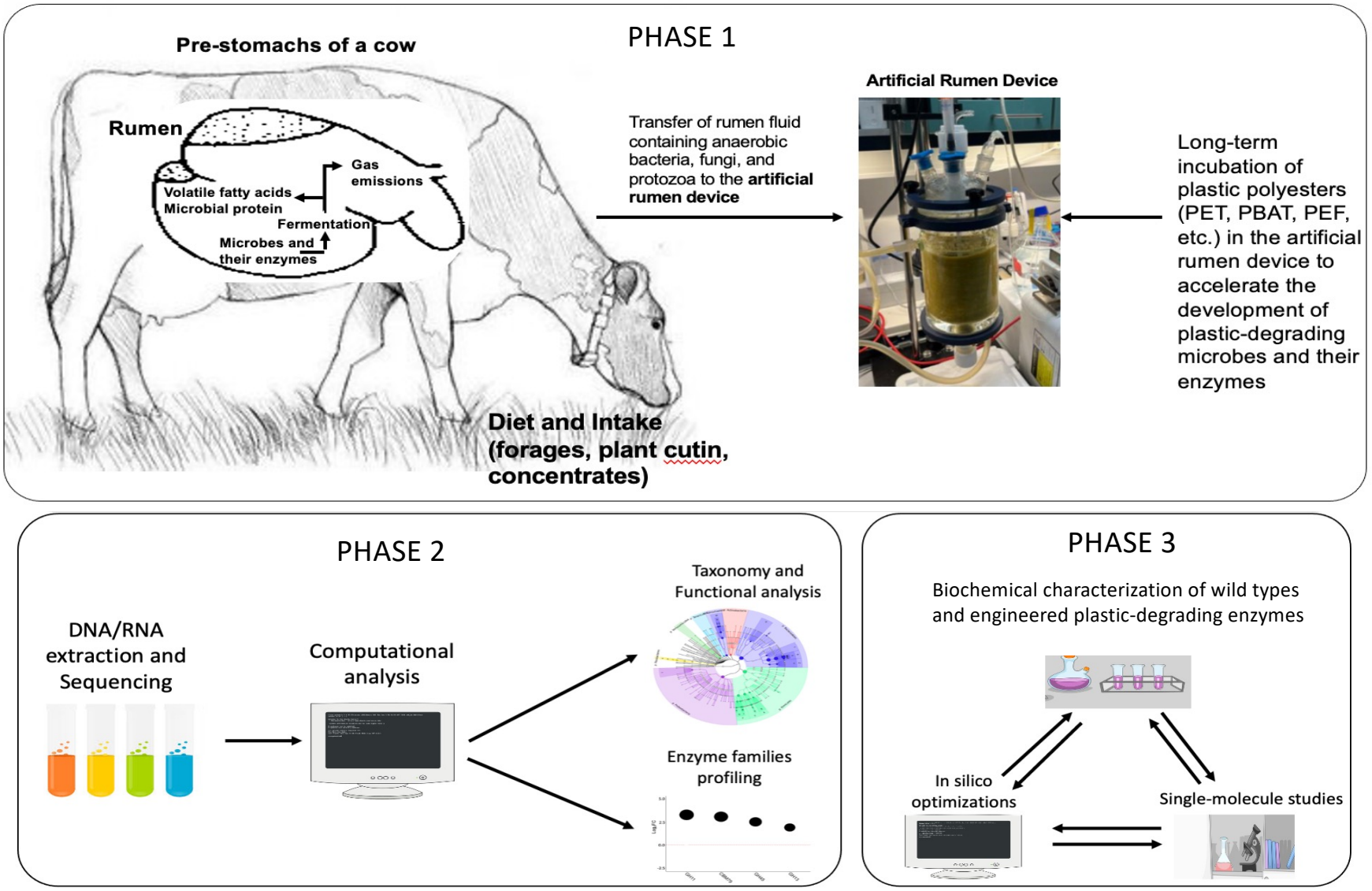
Rumen microbes

TEREPHTHALIC ACID





Present after 96 hours of incubation – LC/MS analysis


PHASE 1
Pre-stomachs of a cow
Rumen
Gas emissions
Volatile fatty acids
Microbial protein
Fermentation
Microbes and their enzymes
Diet and Intake (forages, plant cutin, concentrates)
Transfer of rumen fluid containing anaerobic bacteria, fungi, and protozoa to the artificial rumen device
Artificial Rumen Device
Long-term incubation of plastic polyesters (PET, PBAT, PEF, etc.) in the artificial rumen device to accelerate the development of plastic-degrading microbes and their enzymes
PHASE 2
DNA/RNA extraction and Sequencing
Computational analysis
Taxonomy and Functional analysis
Enzyme families profiling
PHASE 3
Biochemical characterization of wild types and engineered plastic-degrading enzymes
In silico optimizations
Single-molecule studies

Deliverables - Enzyme candidates can provide technological solutions to harmful polyester plastics, facilitating the reuse of commodity chemicals that can again be used in clothing, paints, drugs, etc.

Success criteria - Our pilot study has already revealed that PET, the most important polyester used in numerous applications, can be broken down into its raw commercial component, terephthalic acid, by rumen microbes - (Proof-of-Concept).

We envisage our research facilitating National commitments to truly recycle 50% of all plastics used, as well as create a circular plastic economy.

Success will depend on the identification of a number of microbes and enzymes capable of degrading common plastics into their commercial components, so they can be reused 100% without loss of quality – generating a sustainable income for Denmark.

”Any Questions ?” - Thank you from André & Adrian

KO-STOF

Ko til Stof