

10 jaar biotechnologische ontwikkelingen in afvalwaterzuivering..... en door

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Challenge the future

40 jaar biotechnologische ontwikkelingen in afvalwaterzuivering..... en door

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Challenge the future

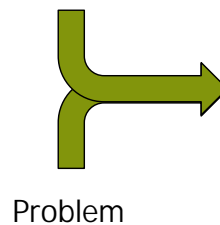
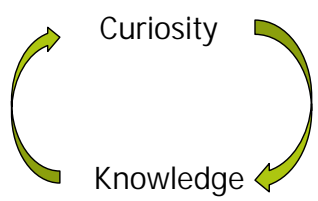
Content

Advances in Knowledge that generated new Processes

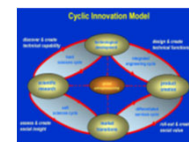
- Biological Water Treatment
- Resource Recovery



INNOVATION

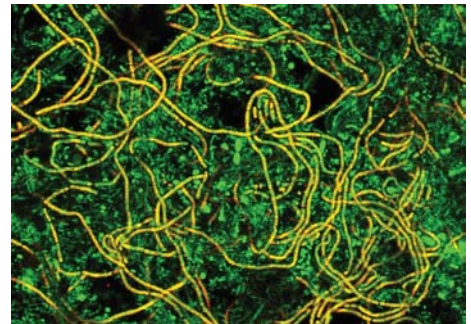
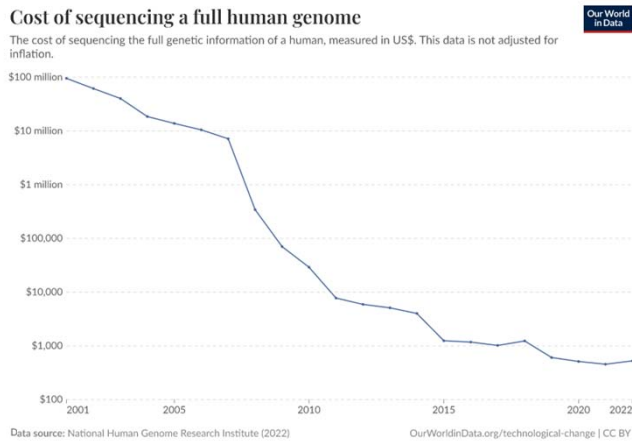


Potential for Innovation



Biological Sciences

Revolutionised in the past 40 years



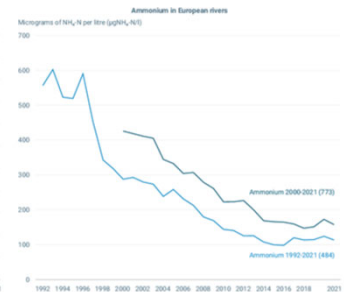
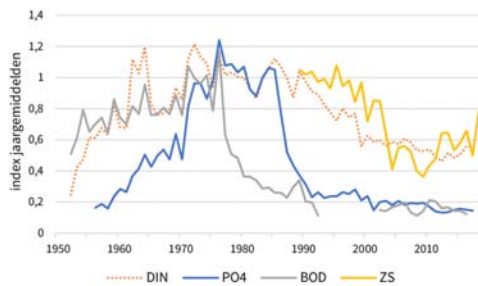
3.000.000.000 base pairs

Technology 1970: WvO introduced

Led to development of UASB, IC, CIRCOX and Paques and Biothane



Improvements



Granular Sludge

Best of both worlds

Optimal Biofilm/Flocs Combination

- Easy, gravity driven, separation
- High biomass concentration possible
- High mass transfer area
- Mixed reactors and no clogging
- Structuring allows efficient microbial community design



Is granular sludge specific for methanogenic systems
Or can all bacteria grow in granules?



Morphogenesis of Granules/Biofilms

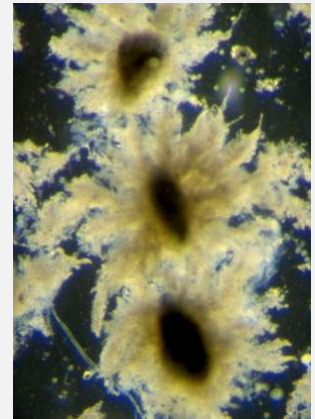
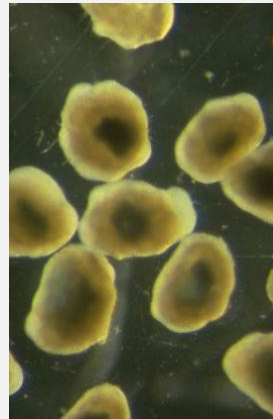
Biology is not needed to understand Granular Sludge formation

Biology is needed to understand the conversion processes in the reactors

High similarity in morphogenesis of crystals and biofilms/granules

Compact Morphology

- Slow rates (Methanogens, Anammox)
- No diffusion limited substrate uptake
- Shear can counteract



Nereda Utrecht wwtp



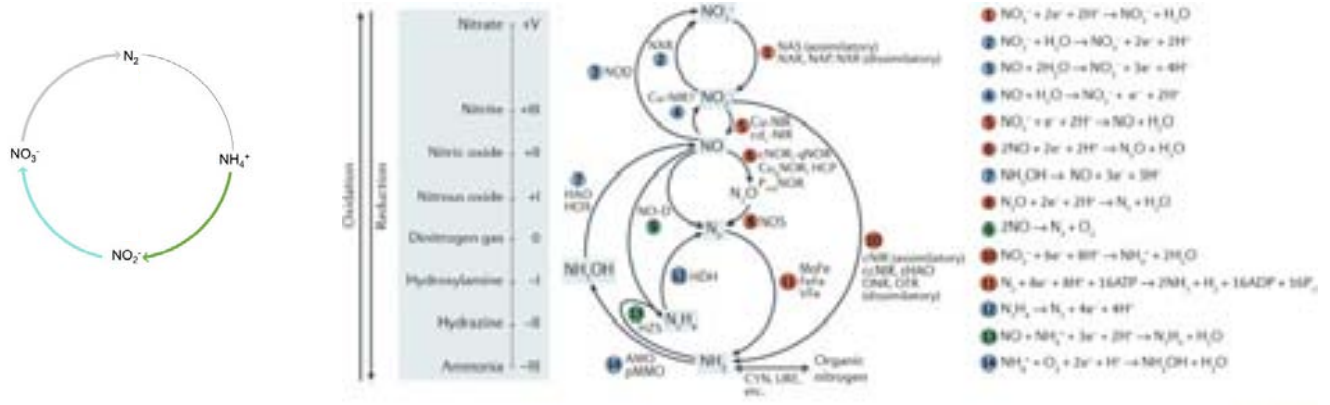
Aerobic Granular Sludge - Nereda



11

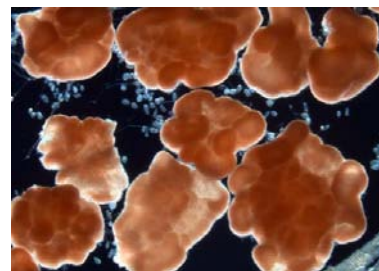
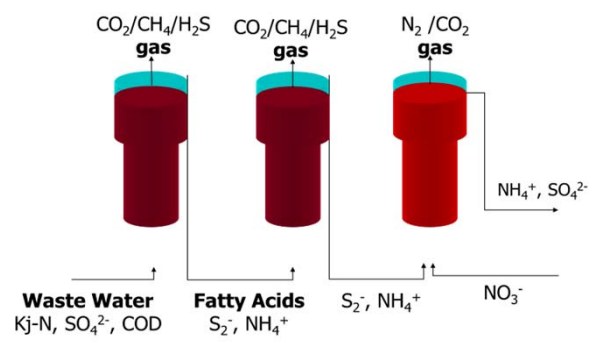
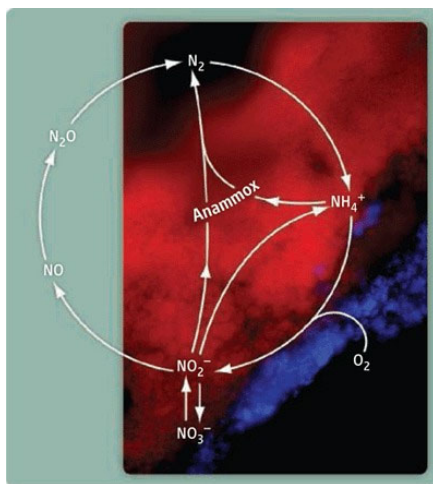


Nitrogen Cycle



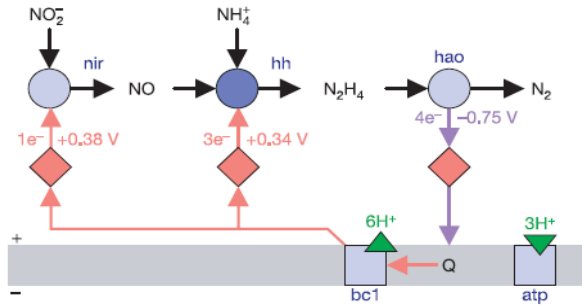
Nature Reviews | Microbiology

Anammox

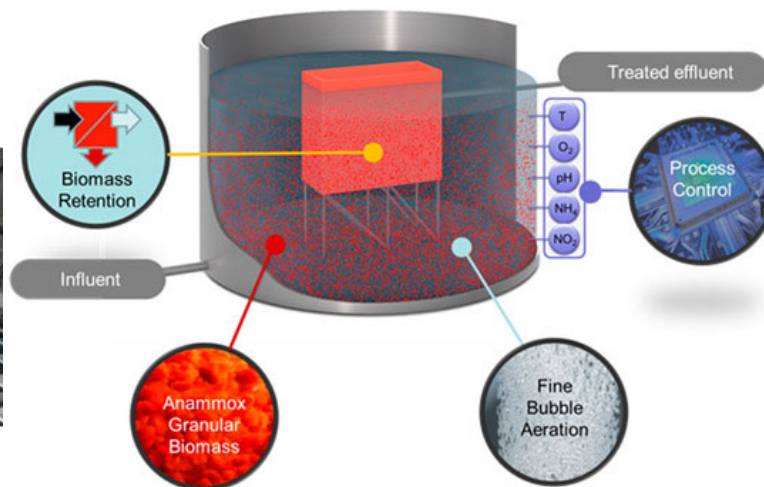


Anammox

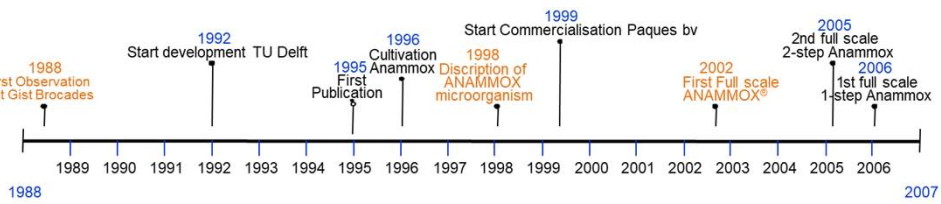
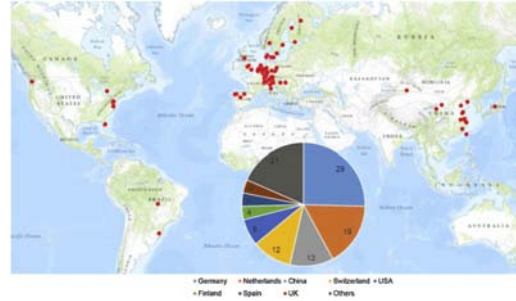
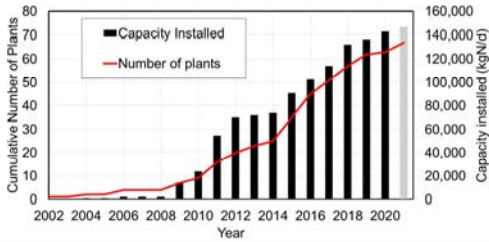
Dogma: Ammonium needs oxygen to be oxydised



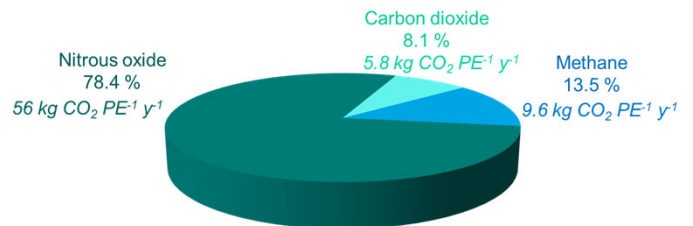
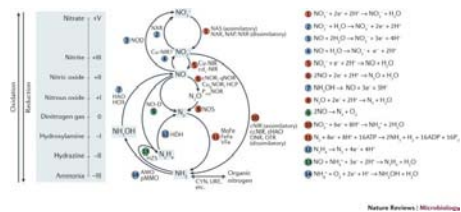
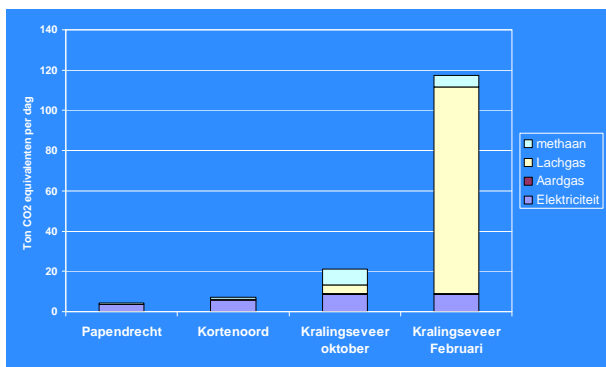
Anammox reactor



Anammox



Nitrous Oxide Emissions



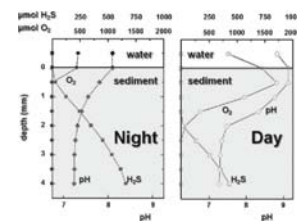
Nature: Chemostats and Batch reactors hardly exist

Natural system is dynamic

- Day/Night
- Tidal zones

Bacteria have adapted with a wide range of competitive strategies

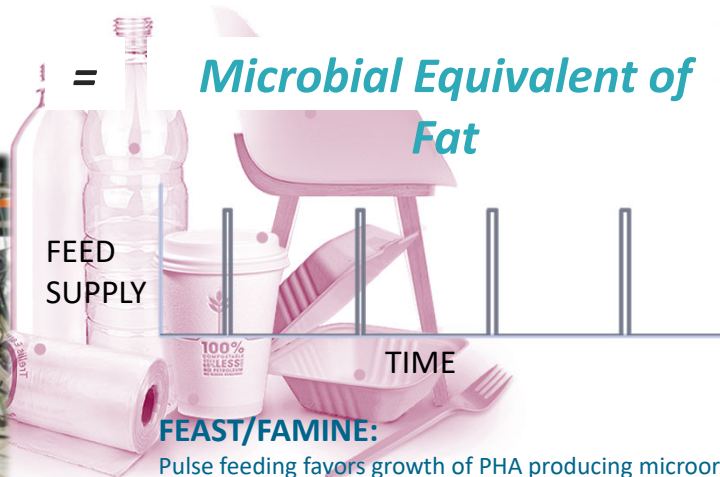
Mainly based on storage polymers



Microbial enrichment: SURVIVAL OF THE FATTEST

PHA

= **Microbial Equivalent of Fat**

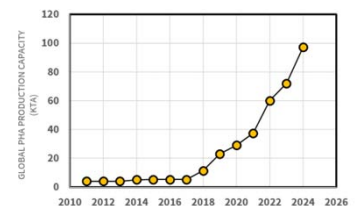


FEED SUPPLY

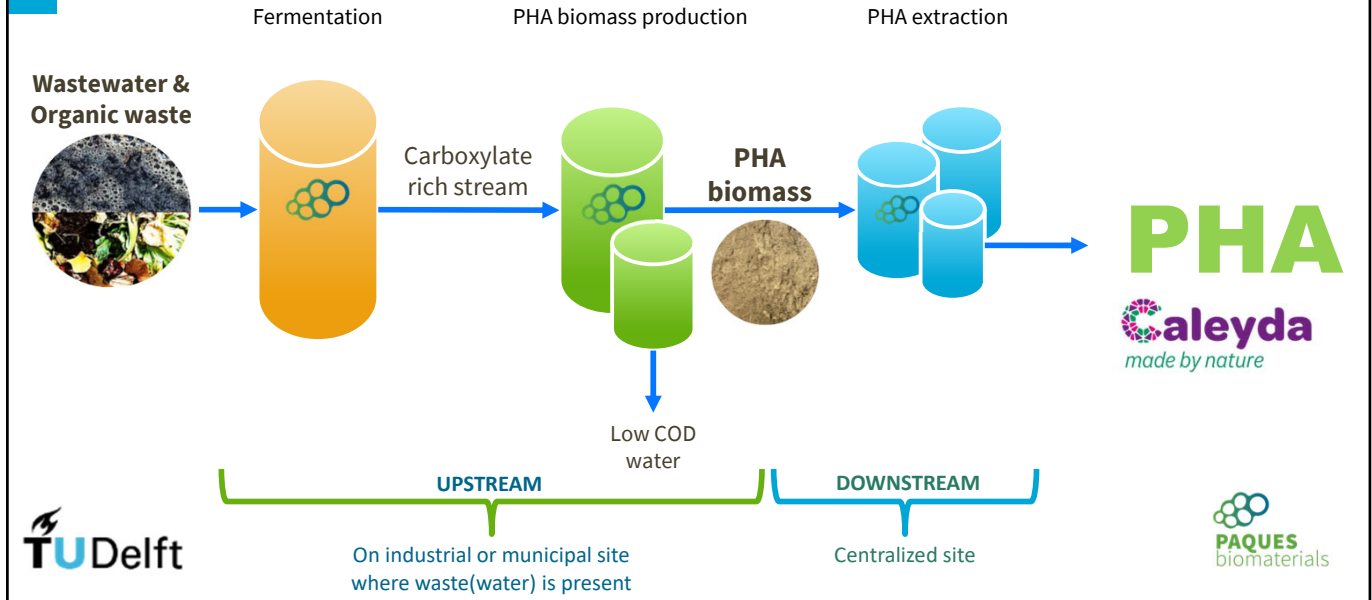
TIME

FEAST/FAMINE:

Pulse feeding favors growth of PHA producing microorganisms
(Subject the culture to fluctuating environmental conditions)



The steps to making **Caleyda**[®]



Well tested in real life conditions. Ready for scale-up

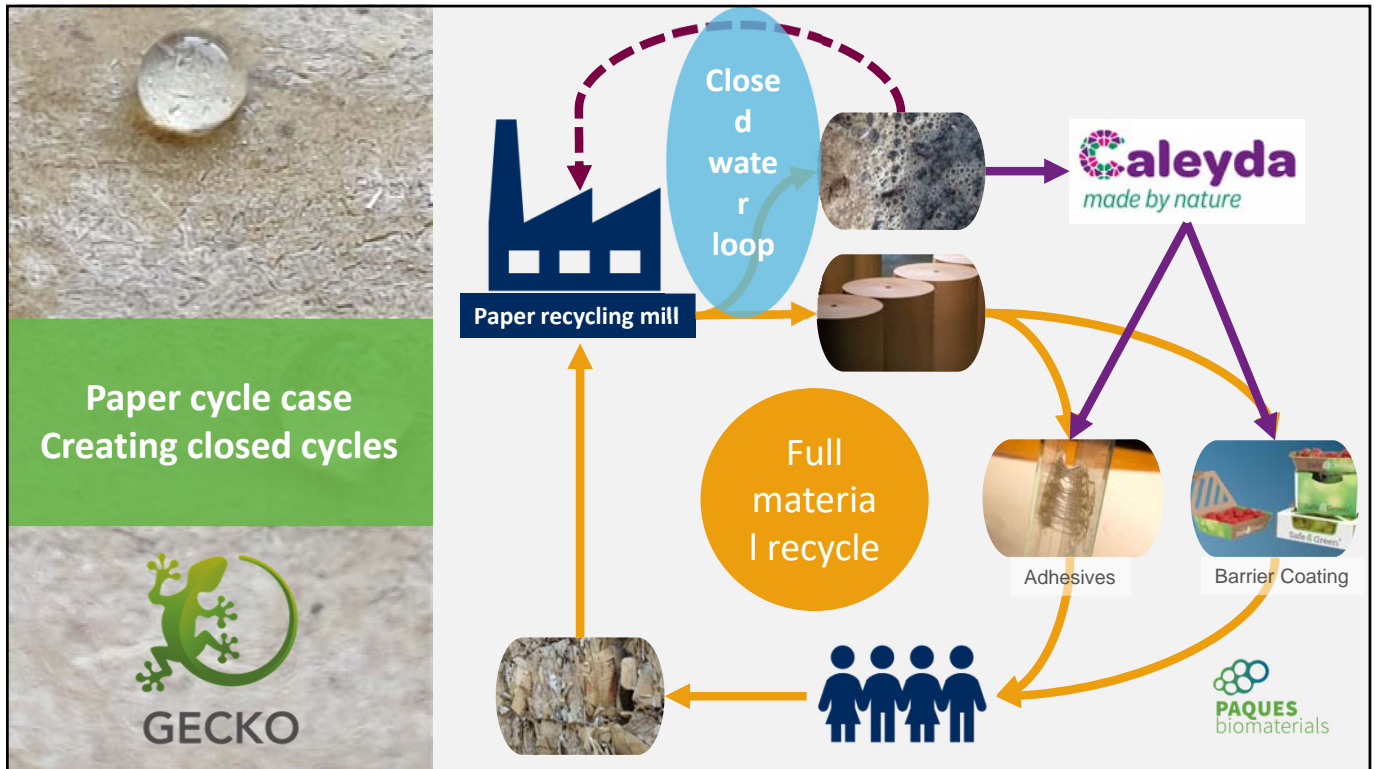
MARS
2012-2014

ESKA
2014-2015

renewi
2015-2021

Smurfit Kappa
2022-2024

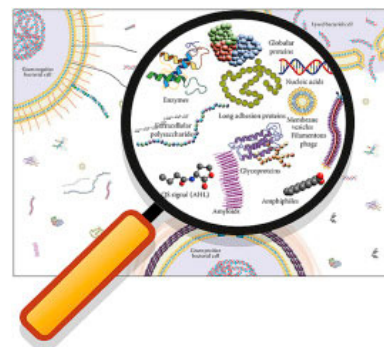
PAQUES biomaterials



Extracellular polymers

Poorly understood:

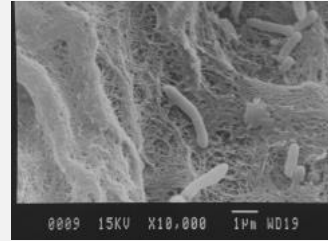
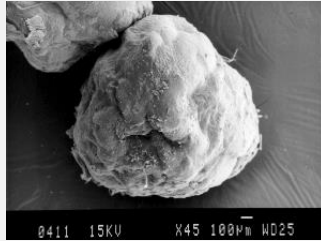
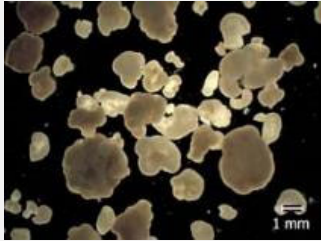
- Wrong extraction methods
- Poor chemical analysis
- Sugar polymers



A strand of 6 monomers (beads)

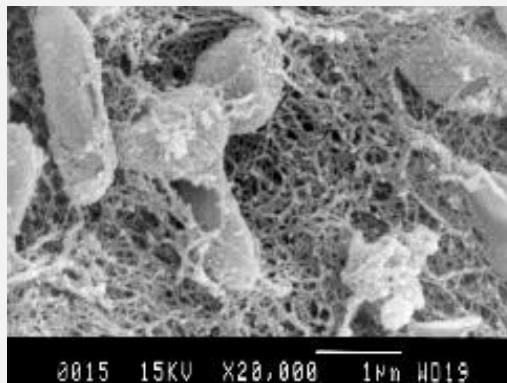
DNA	- 4 Nucleotides	- 1 link	- 4069 possibilities
Protein	- 20 amino acids	- 1 link	- 64×10^6
Poly sugars	- 12 C6 Sugars	- 11 links	- 144×10^{13}

Kaamera: The matrix biopolymer of granular sludge

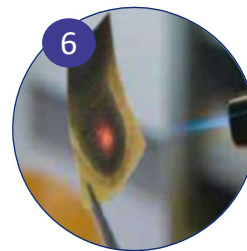


Current potential Kaamera production 35.000 ton – 5 kg per person per year.

Plastics is about 50 kg per person per year, so Kaamera from sewage alone is about 10% of the solution.



PROMISING APPLICATIONS



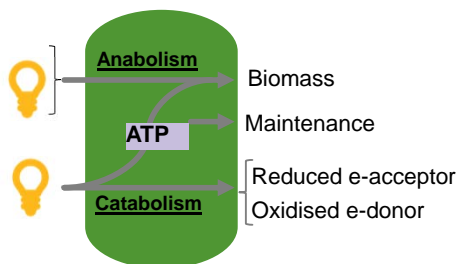
- 1 Coating Agent
- 2 Super-Absorbent Biopolymer
- 3 Paper & Board Coating
- 4 Bio-stimulant
- 5 Binding Agent
- 6 Bio-nanocomposite Materials

Light driven Microbiology



Phototrophic bacteria

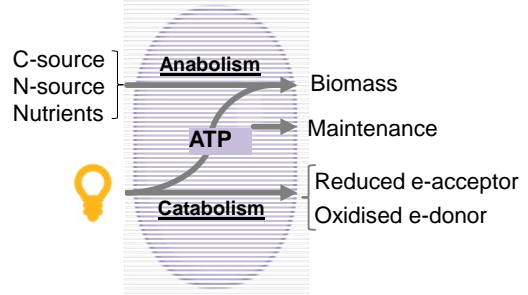
Purple non-sulphur bacteria



ATP Production per Photon

- PNSB: 2x more than Microalgae
- More energy-efficient for biomass production
- Better utilization of available light

Purple non-sulphur bacteria



Light Wavelength Utilization

- PNSB: absorbs 2x wider light spectrum than Microalgae
- Uses infrared and visible light, not just blue/red
- Thrives in low-light environments



Conclusions

Environmental Biotechnology is still a developing field

Good combination of Microbiology and Engineering essential



Acknowledgements

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Dozens of Enthusiastic
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