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Current Opinion in Biotechnology

Enzyme and metabolic engineering for the production of novel biopolymers: crossover of biological and chemical processes

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The decline in fossil resources has increased the demand for the use of renewable biomasses.

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The biosynthetic systems allow to production of a wide variety of bio-based polyesters.

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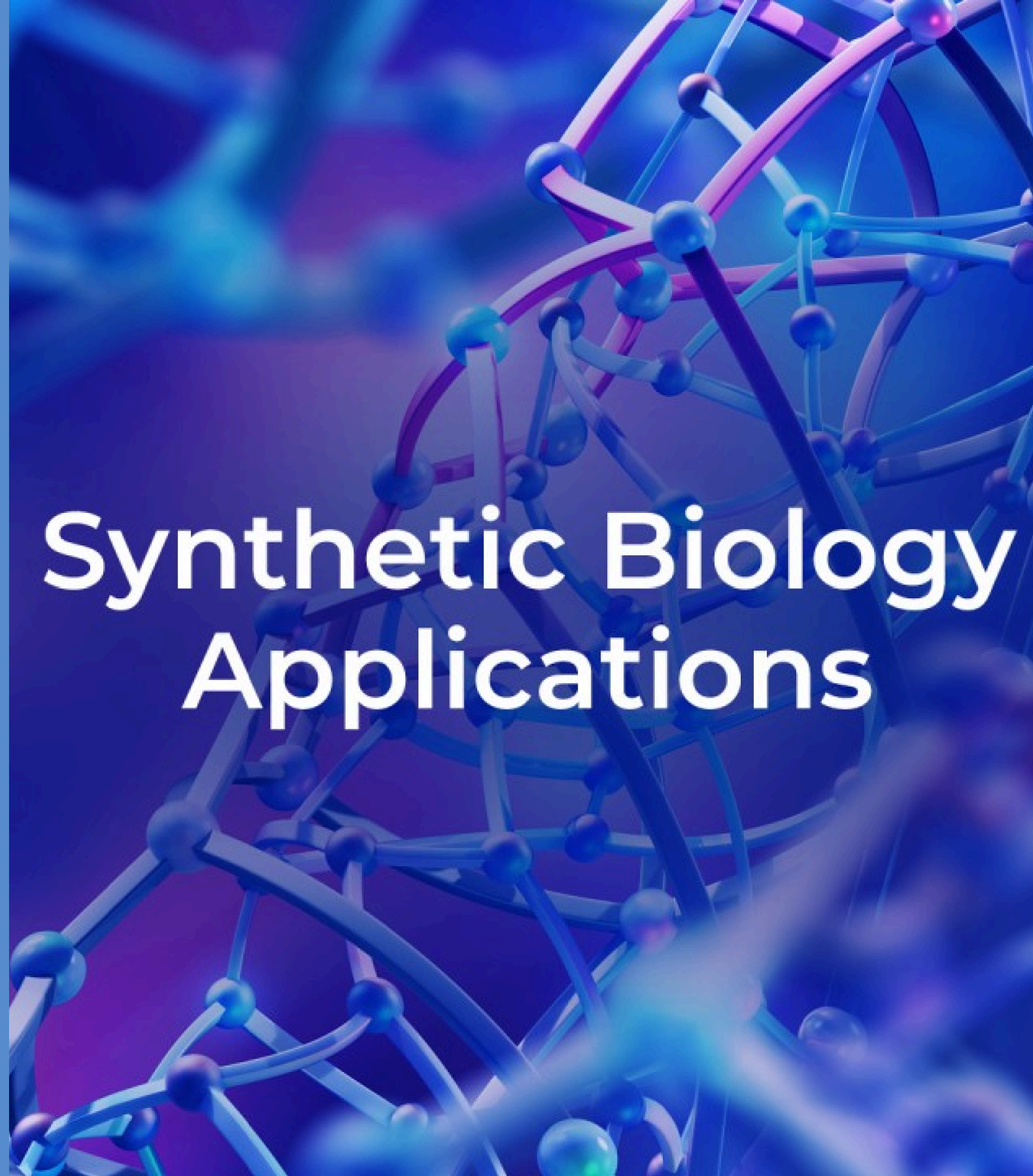
Conclusion

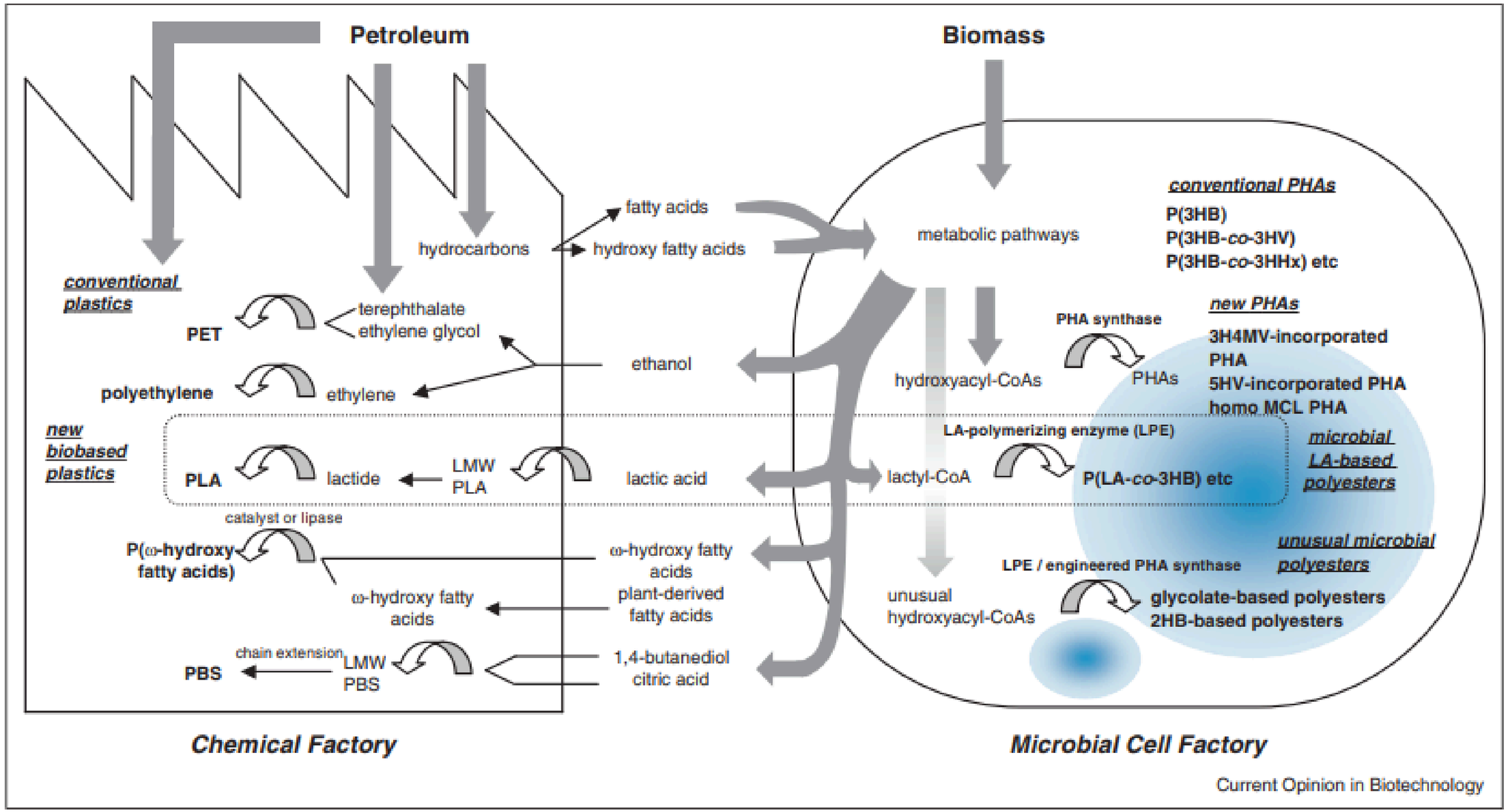
Introduction

Bioprocesses driven by some specific enzymes and metabolic pathways convert crude biomass into the desired precursors

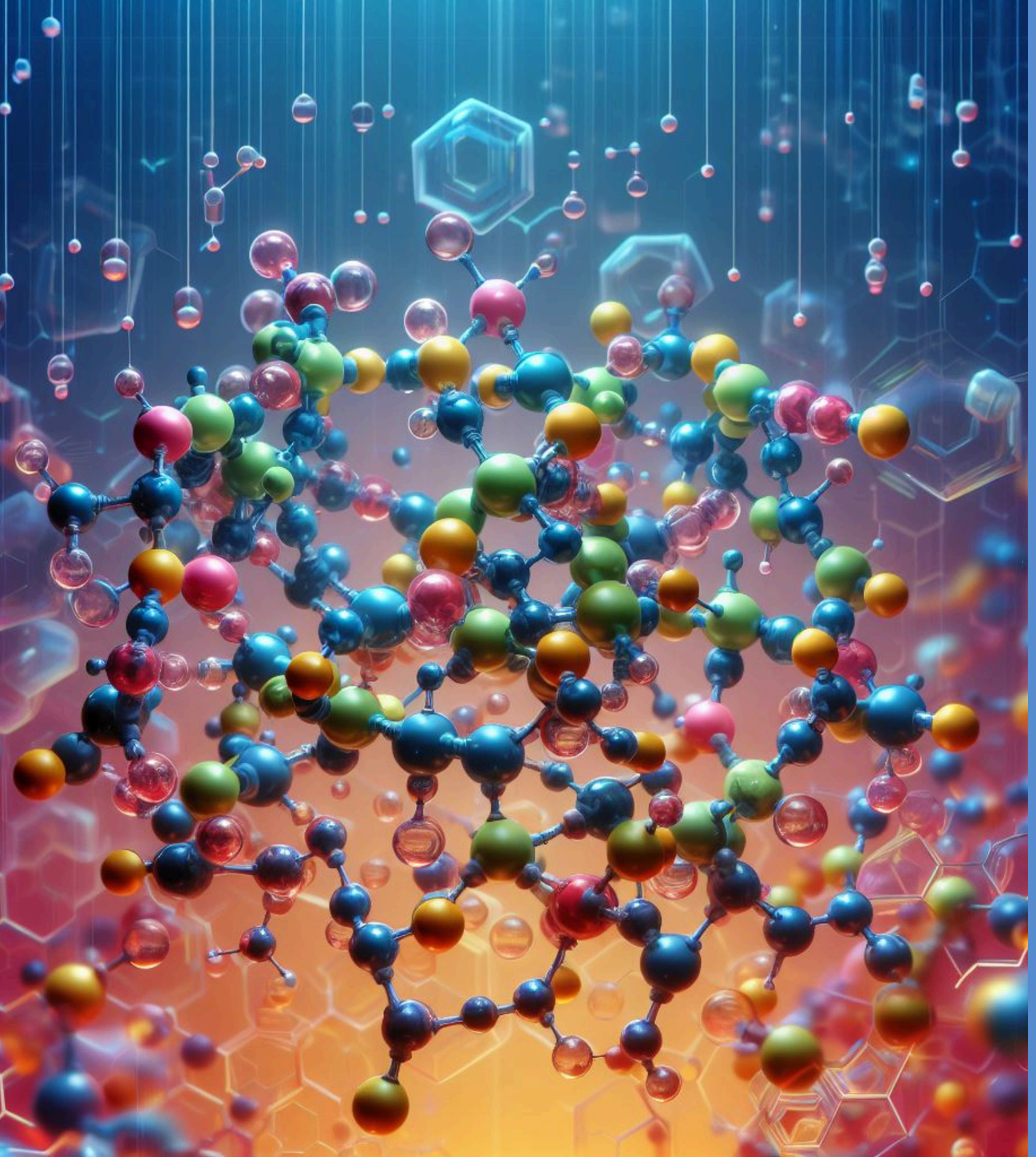


The biosynthetic systems allow to production of a wide variety of bio-based polyesters.

Figure 1



PET, poly(ethyleneterephthalate);
PLA, poly(lactic acid);
PBS, poly(butylene succinate);
LMW, low molecular weight;
PHA, polyhydroxyalkanoate;
LA, lactate;
2HB, 2-hydroxybutyrate;
3HB, 3-hydroxybutyrate;
3HV, 3-hydroxyvalerate;
3HHx, 3-hydroxyhexanoate;
3H4MV, 3-hydroxy-4-methylvalerate;
5HV, 5-hydroxyvalerate;
MCL, mediumchain-length (C6–C12).

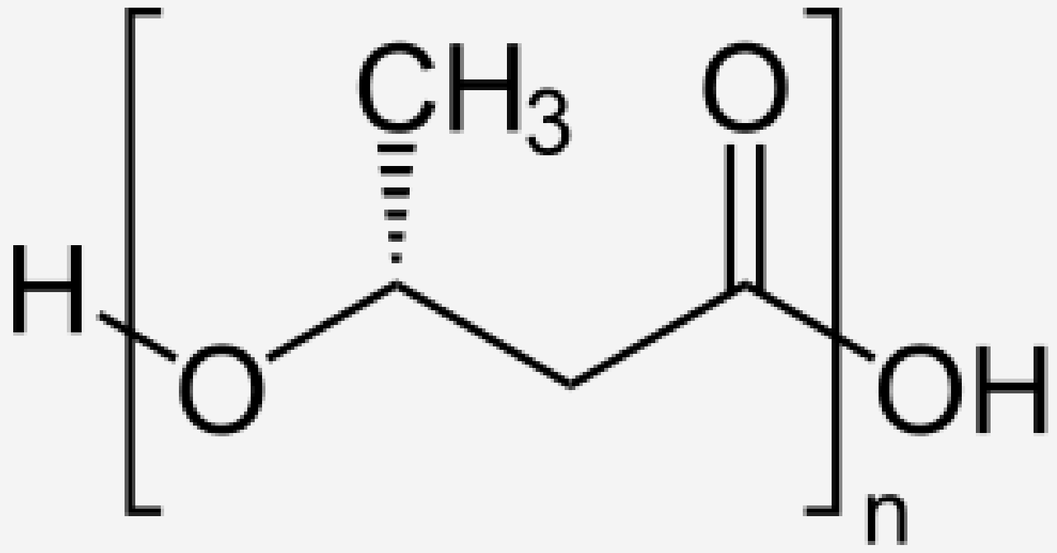


Enzymatic hydroxylation of fatty acids for the production of poly (ω-hydroxy fatty acids)

Poly (ω -hydroxy fatty acids) are plant oil-derived polyesters having attractive properties. For example, poly (ω-hydroxytetradecanoic acid) has an elongation at a break of 730% (meaning that the film can be stretched up to 730% in length before breaking off), which is like high-density polyethylene.

Polyhydroxyalkanoate and their applications

Polyhydroxyalkanoates are bacterial polyesters consisting of hydroxyalkanoates (3HA).



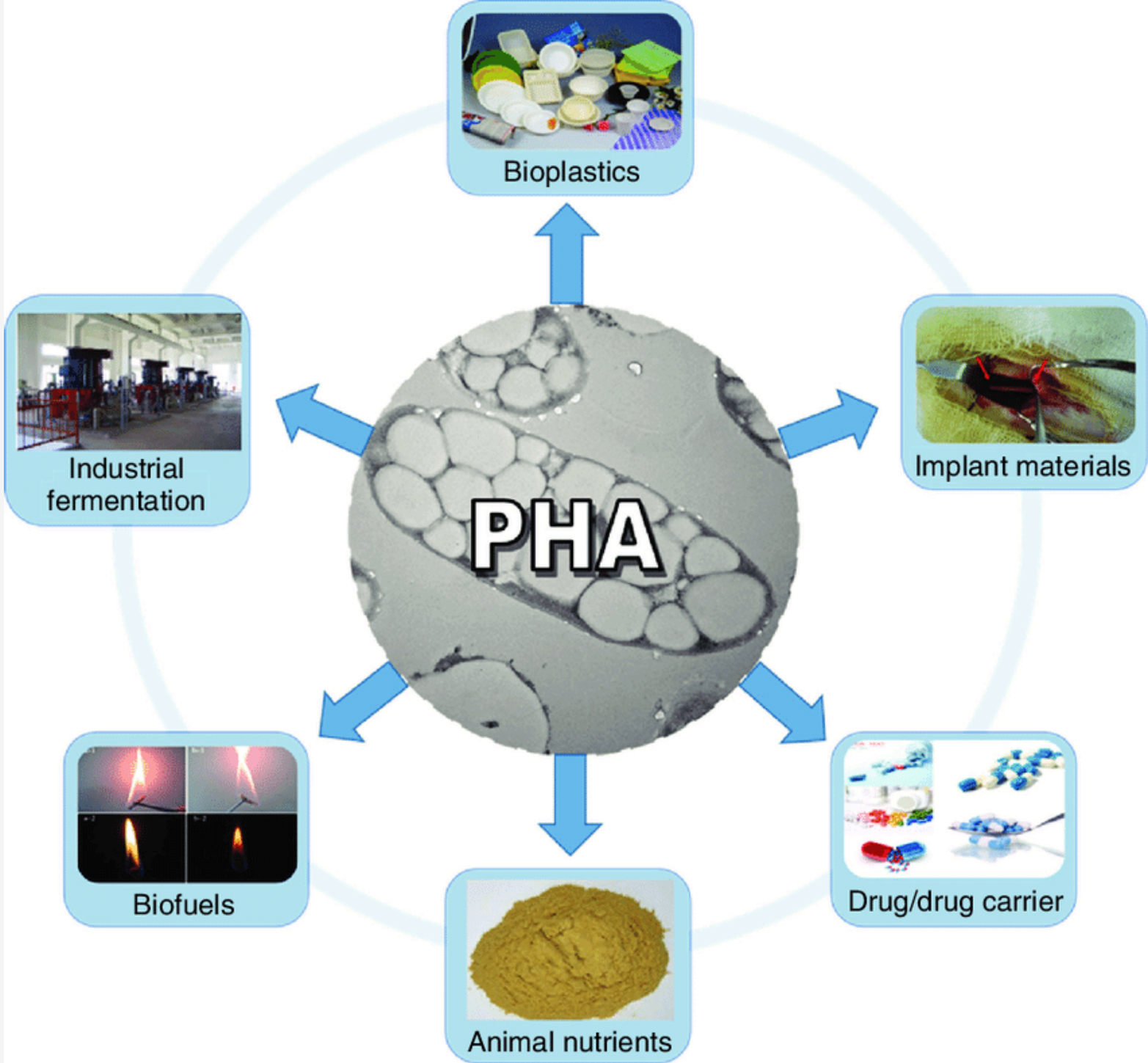
Aonilex® X151A

Technical Datasheet | Supplied by Kaneka

Aonilex® X151A by Kaneka is a plant-oil-based biodegradable polyester. It is produced by microorganisms in a specified fermentation condition using plant oils as the carbon source.

Polyhydroxyalkanoate and their applications

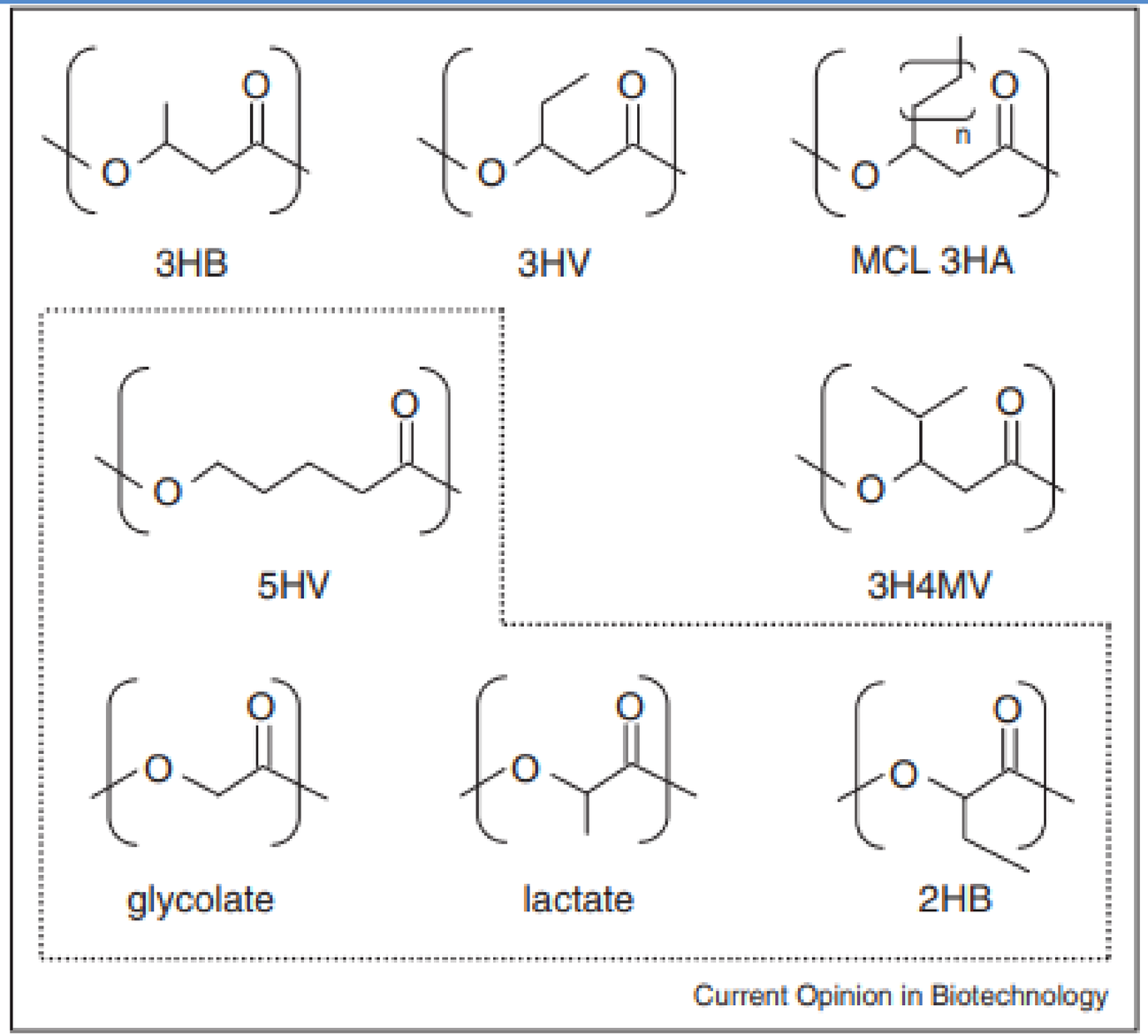
The biodegradability and biocompatibility of PHAs have inspired studies on the use of polymers.



Monomeric constituents of bacterial polyhydroxyalkanoates.

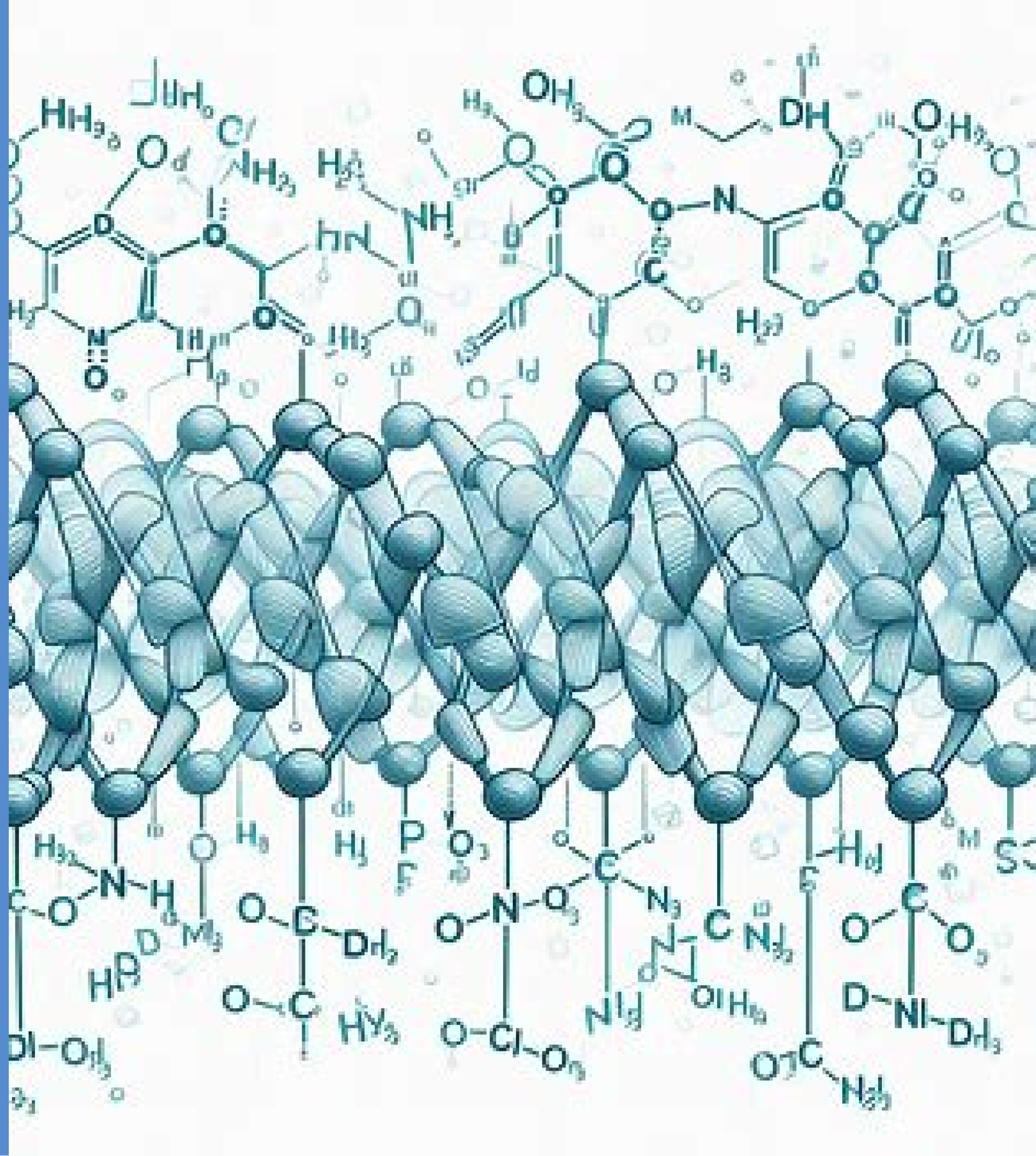
The PHA biosynthesis create a variety of new polyesters.

- **3HB, 3HV, MCL 3HAs and 3H4MV** are naturally occurring monomer units.
- **5HV, glycolate, lactate and 2HB** have never been found in natural PHAs.
- **Monomer units with a 2-hydroxy group** their incorporation has only been achieved using engineered PHA synthase.



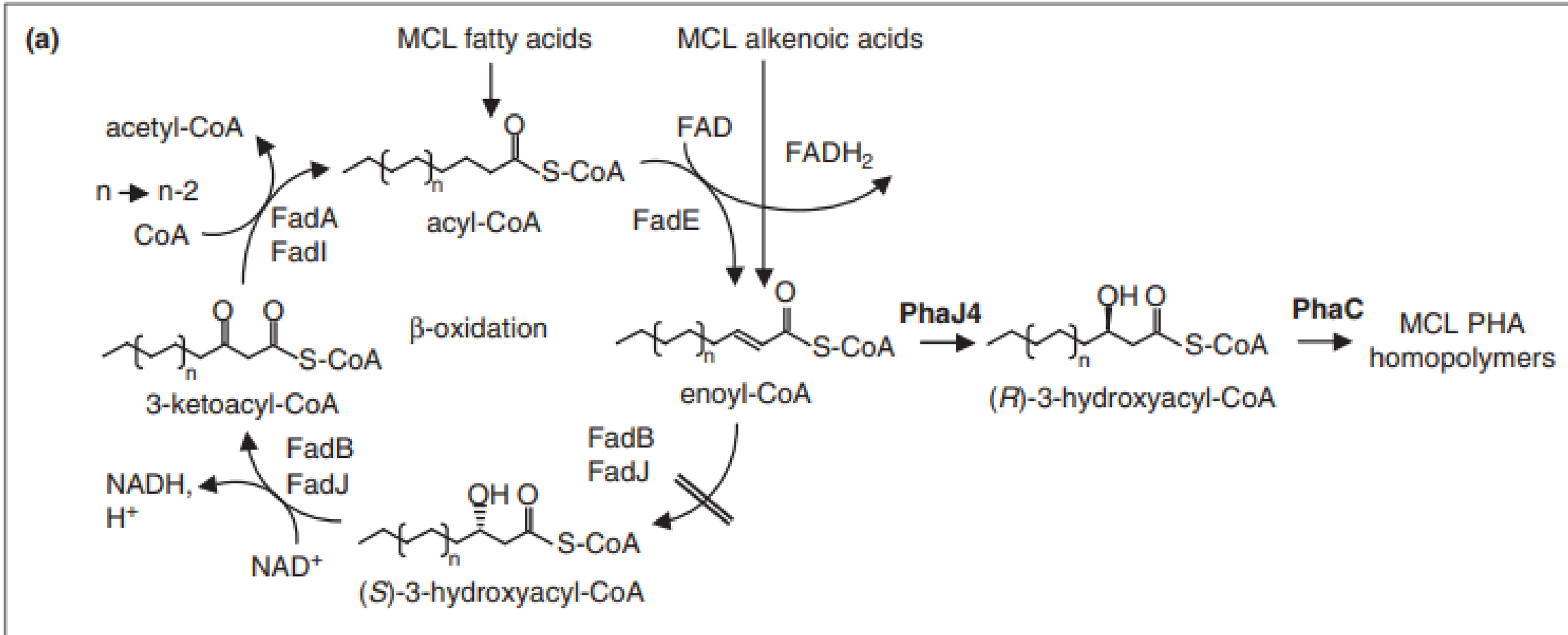
INITIAL STUDY

MCL PHA homopolymers synthesis



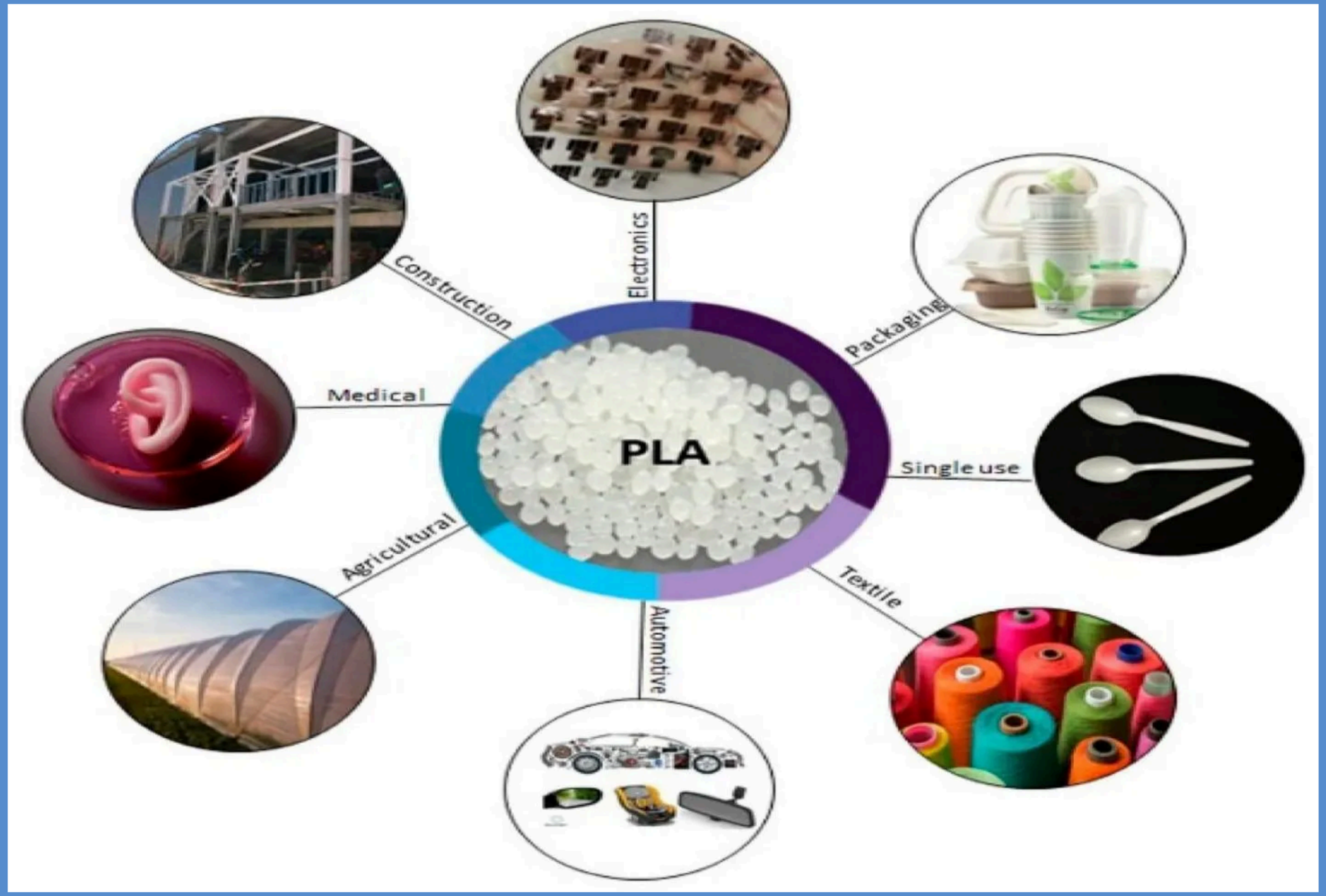
MCL PHA homopolymers synthesis

Figure 3



Polylactic acids and their applications

NatureWorks LLC

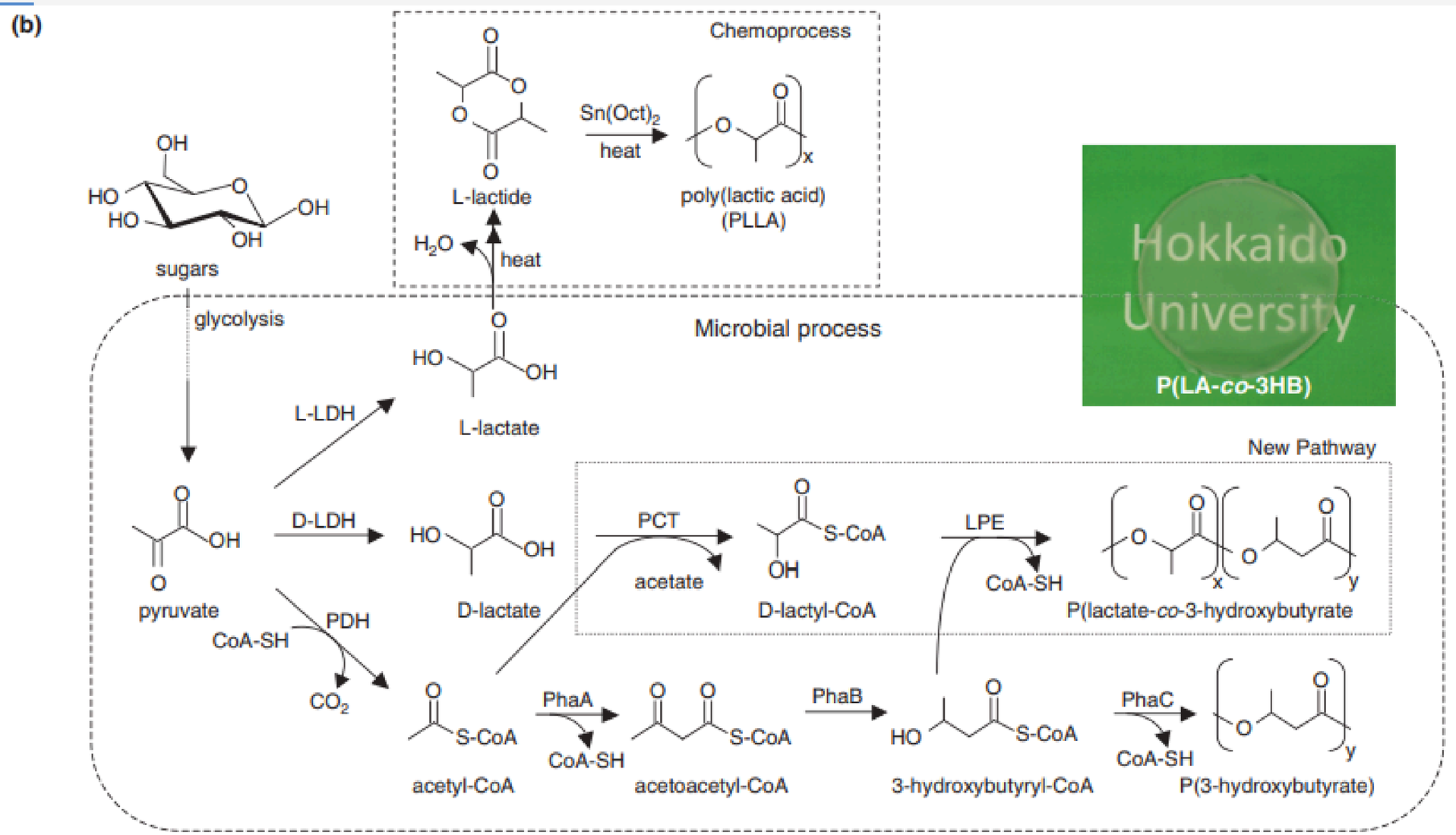


The chemical process for PLA synthesis and the biosynthetic pathway for microbial lactate-based polyester production.

FadB and **FadJ** pathway was blocked, so that PHA consisting of a single monomer unit could be synthesized.

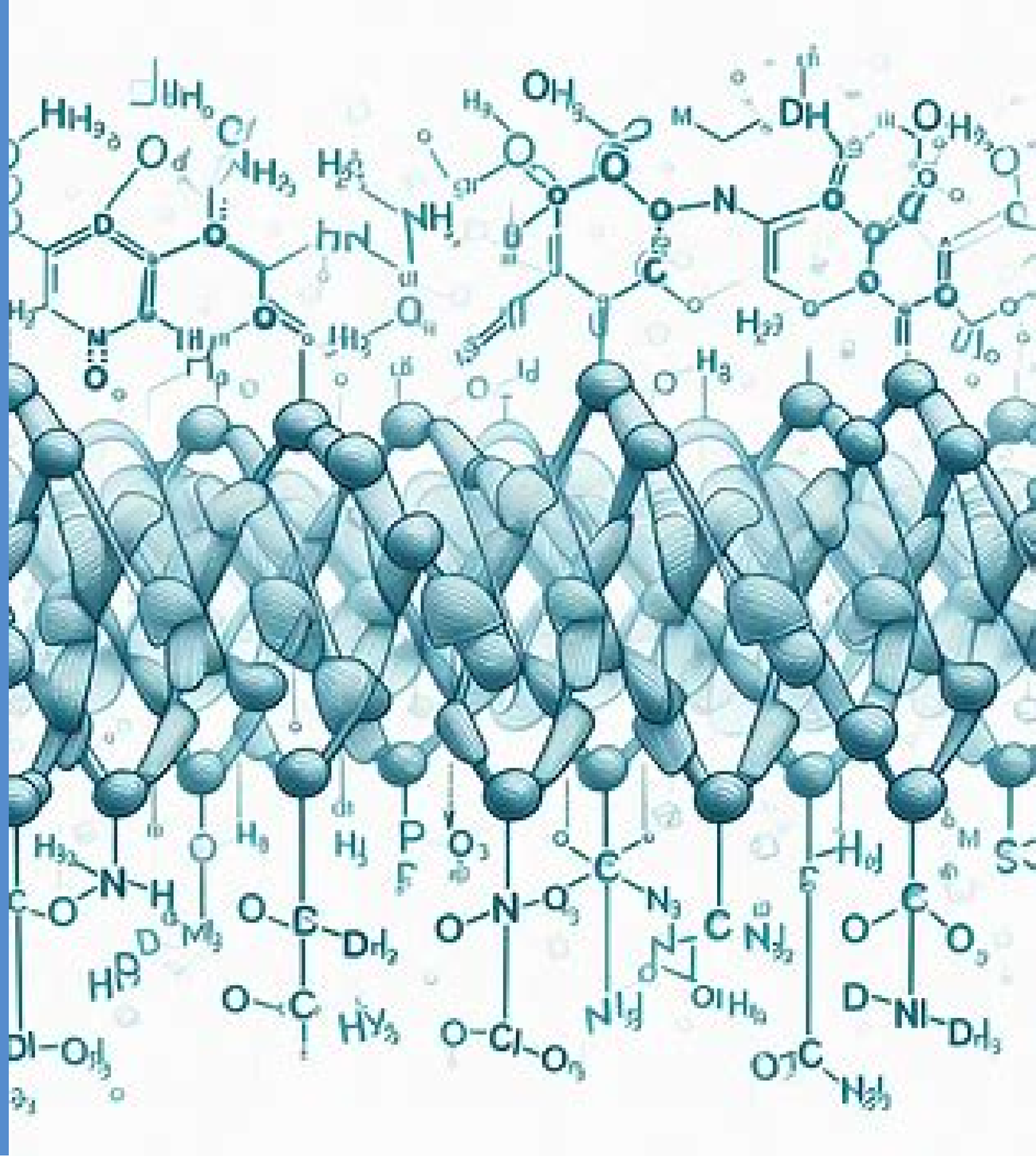
The **PhaJ4**, enoyl-CoA hydratase.

PhaC, PHA synthase



THE NEXT TARGET

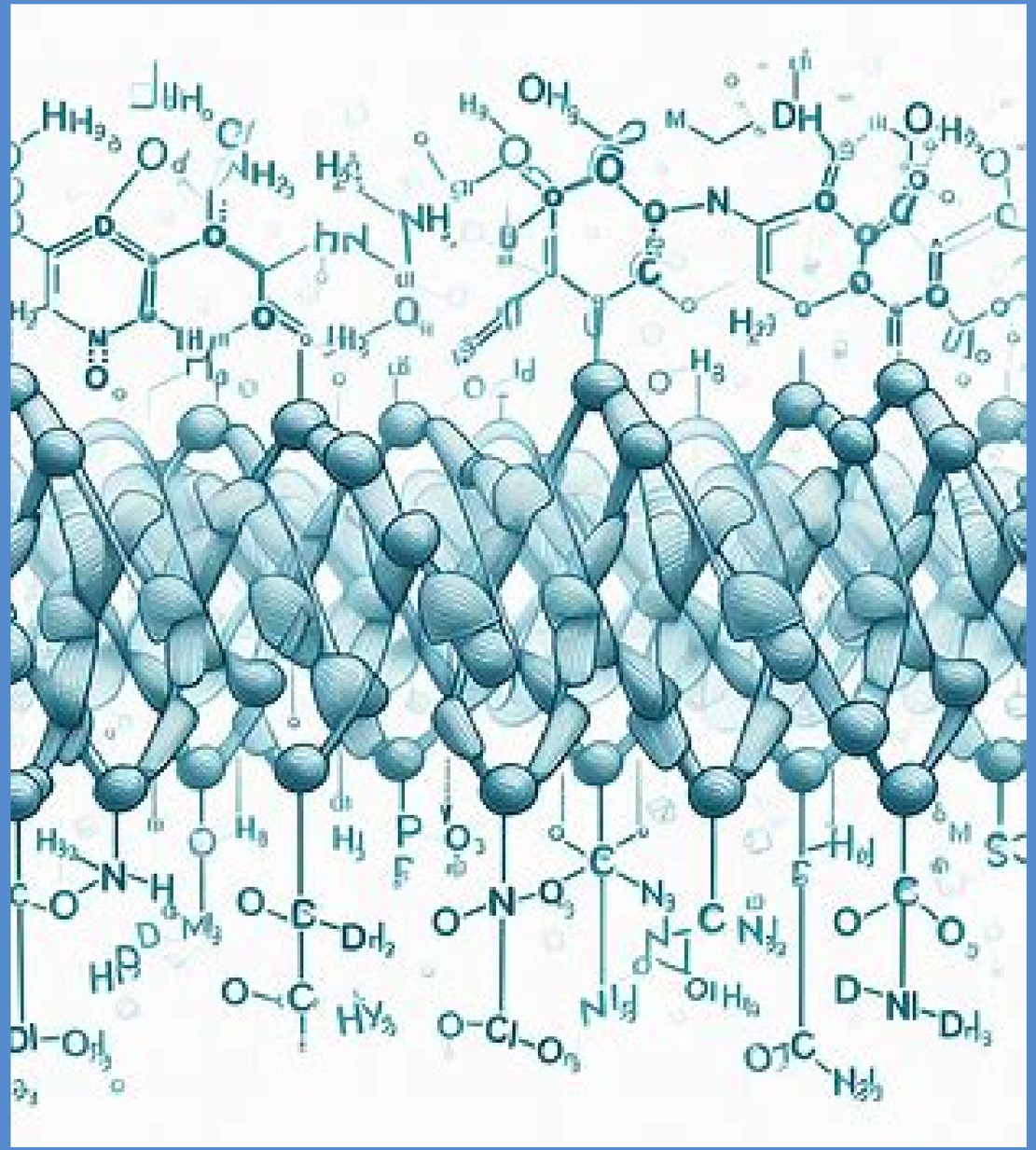
The regulation of the LA fraction in P(LA-co-3HB)



Two chance discoveries have enabled the synthesis of PLA-like polyesters.

It was discovered that the addition of valerate to the medium resulted in the synthesis of P (96% LA-co-3HB-co-3-hydroxyvalerate).

It was found that the recombinant Corynebacterium glutamicum expressing LPE synthesized an LA-based polyester consisting of > 99% LA.



CONCLUSION

Biomass-derived polymers

1

are less toxic

2

are greener alternatives

3

are use in several applications

THANK YOU FOR THE ATTENTION !