



waste2  
biocomp

# Lecture

macromolecules in nature / use of modified biogenic polymeric materials I

training as part of the project: waste2biocomp

Prof. Dr. Gregor Grun

University of applied sciences

Pirmasens, 07.10.2024, 12:30-15:45

Prof. Dr. G. Grun, Introduction to  
Macromolecular Chemistry, WS2024-25

Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Health and Digital Executive Agency (HADEA). Neither the European Union nor the granting authority can be held responsible for them.



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Datum: 07.10.2024 **Anzeigen** **Heute**

KW 41	Montag
<< >>	07.10.2024
7 – 8 Uhr	
8 – 9 Uhr	08:30-11:45 C139   PS <span>4 </span>
9 – 10 Uhr	ChMTLL <span>L LT20 5</span> Prof. Dr. Gregor Grun
10 – 11 Uhr	
11 – 12 Uhr	
12 – 13 Uhr	12:30-15:45 <span>17 </span>
13 – 14 Uhr	B012 - Athen   PS <span>V AC17 3</span>
14 – 15 Uhr	Polychem <span>LT20 3</span> Prof. Dr. Gregor Grun
15 – 16 Uhr	

Prof. Dr. G. Grun, Introduction to  
Macromolecular Chemistry, WS2024-25

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# What is a macromolecule?

# What in nature is made of macromolecules?

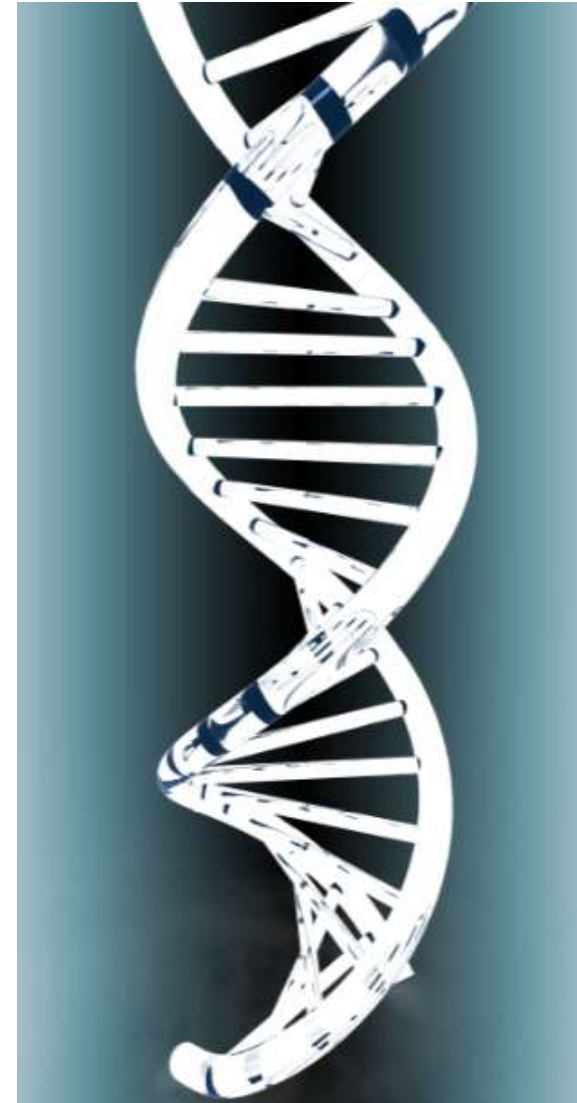
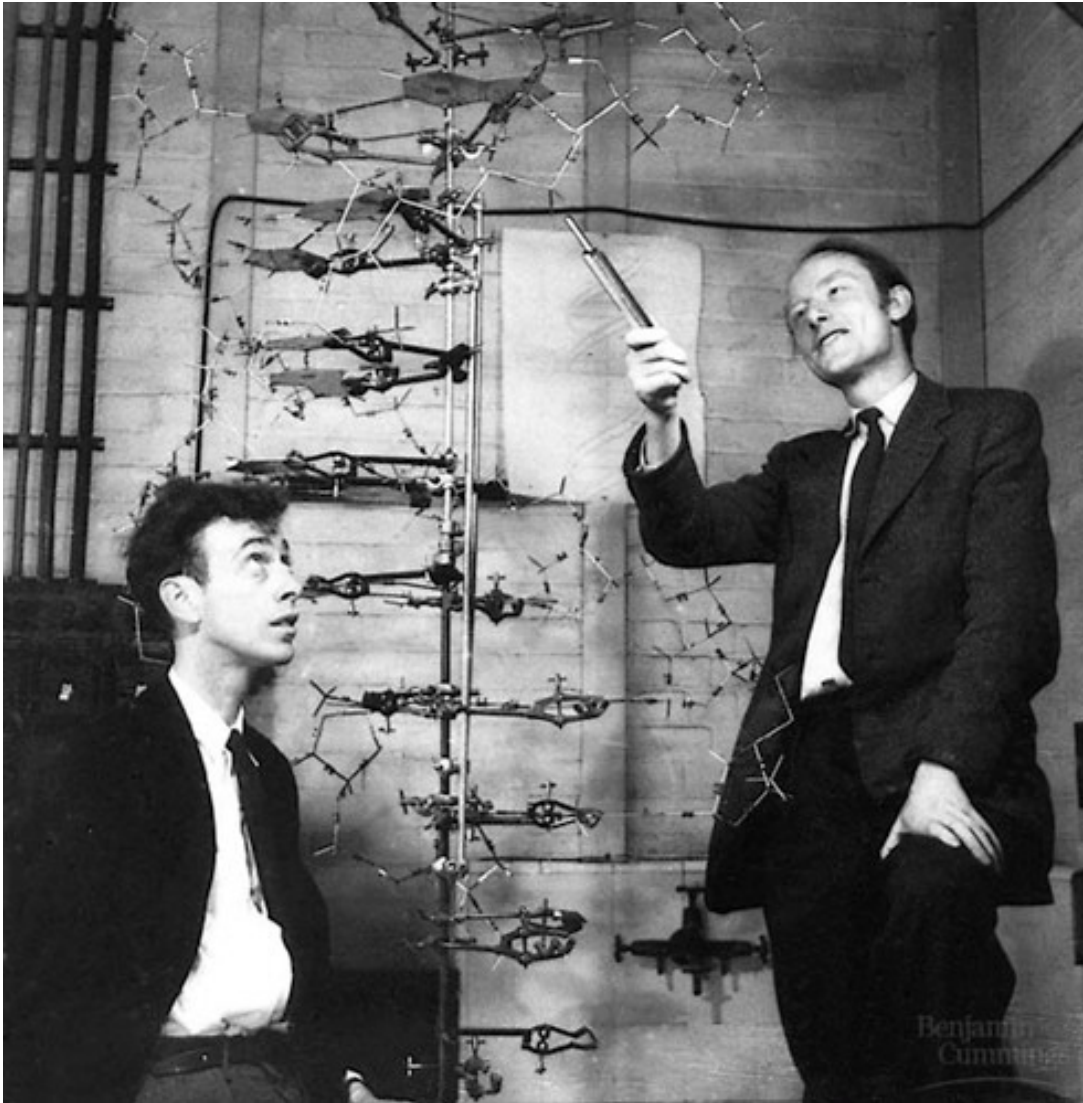


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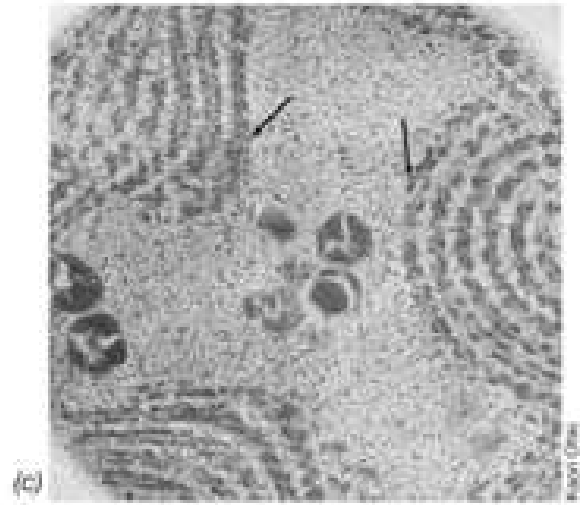
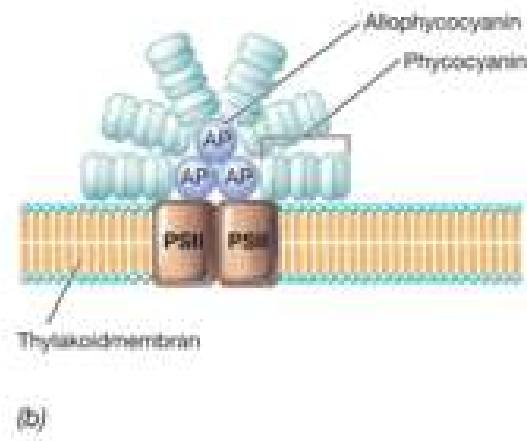
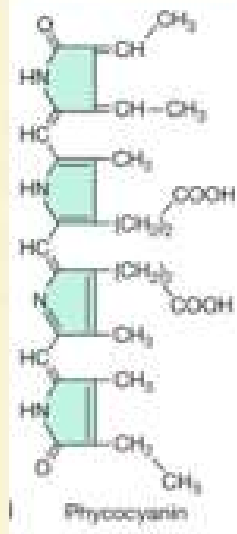
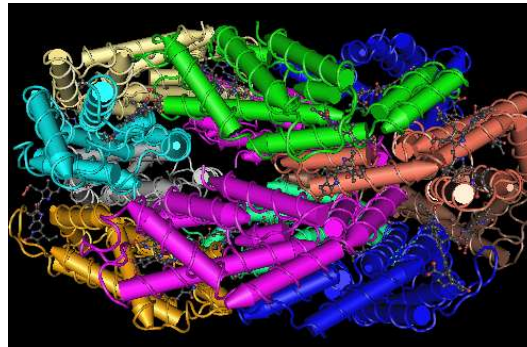




# What in nature ist made of macromolecules?

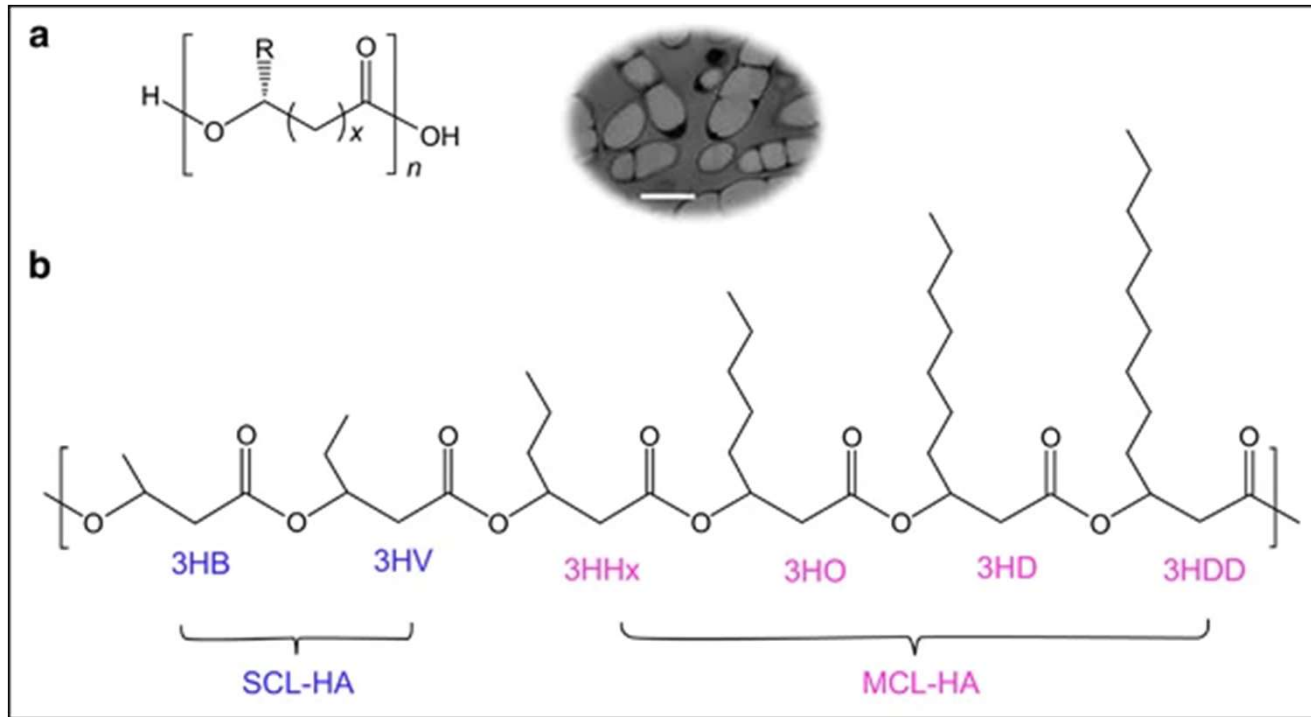


# What in nature ist made of macromolecules?



Reference: Photoproma (EFRE-project 2018-2021)

# What in nature ist made of macromolecules?



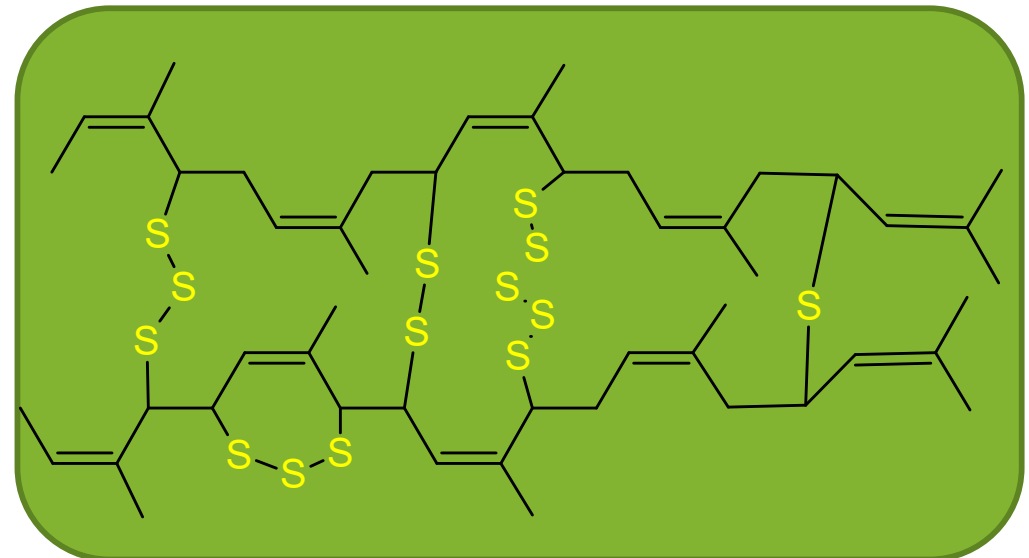
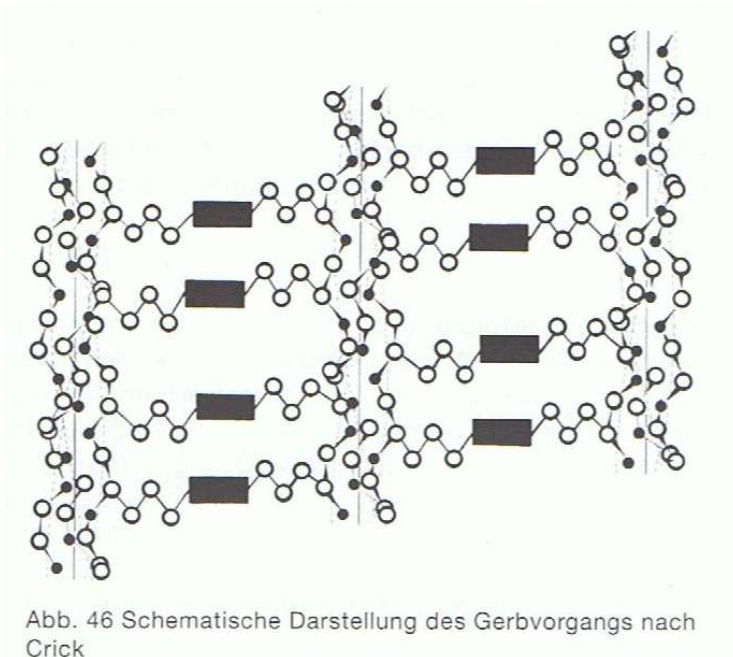
Quelle:

Li, Z., Yang, J. & Loh, X.

Polyhydroxyalkanoates: opening doors for a sustainable future.

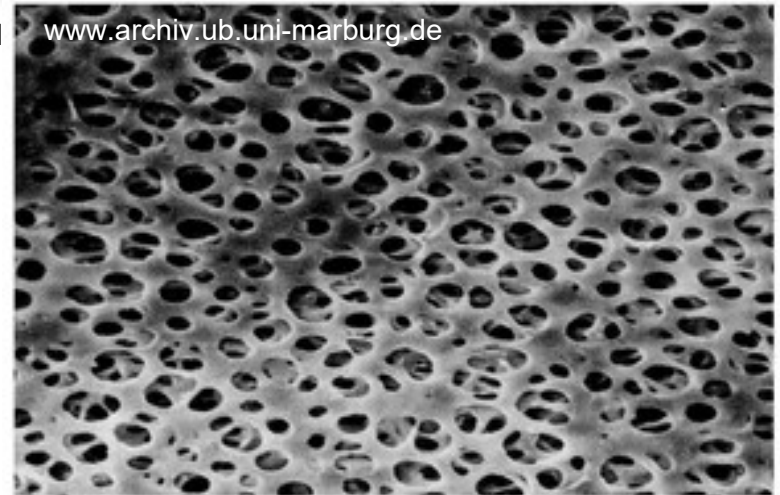
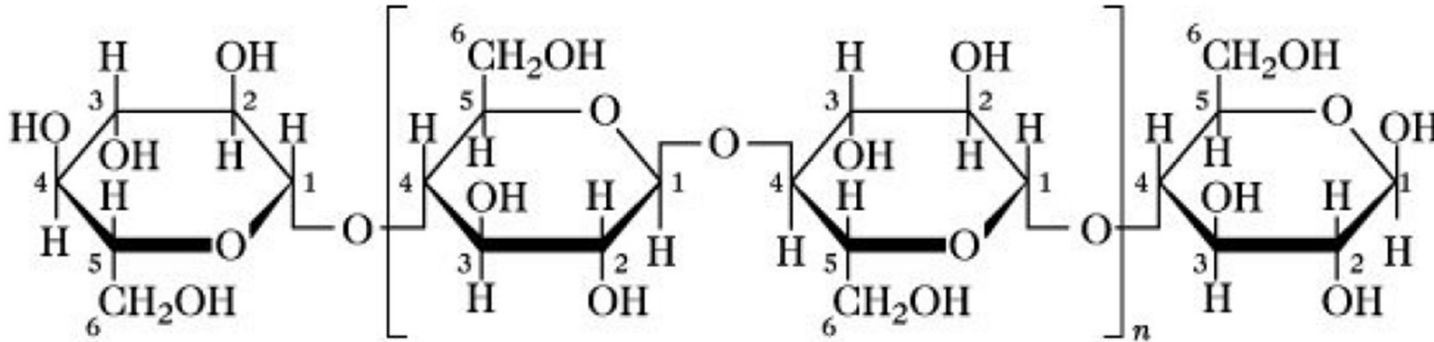
*NPG Asia Mater* 8, e265 (2016). <https://doi.org/10.1038/am.2016.48>

# Modified biogenic macromolecules





# Modified biogenic macromolecules



# Modified biogenic macromolecules

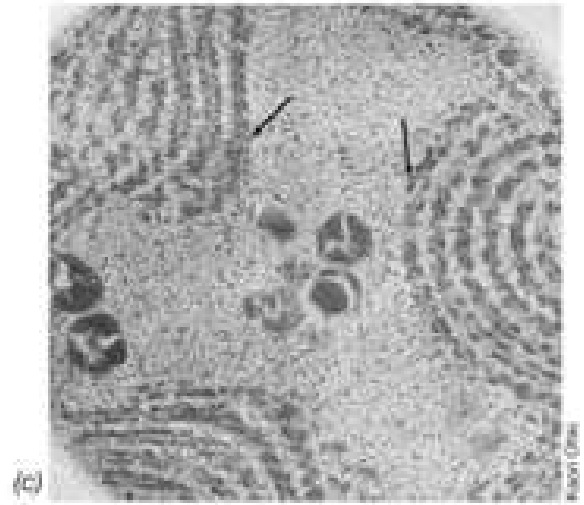
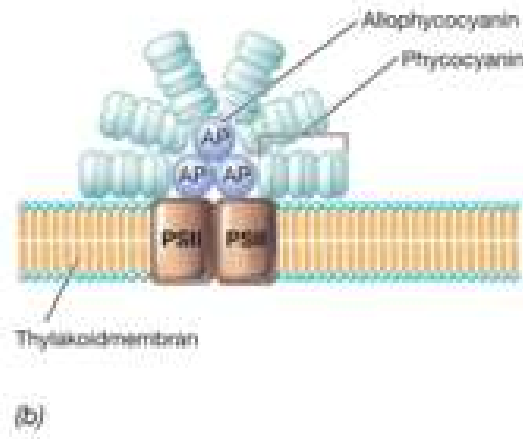
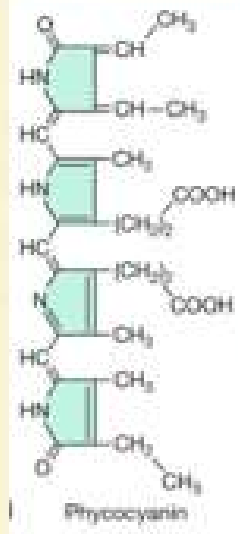
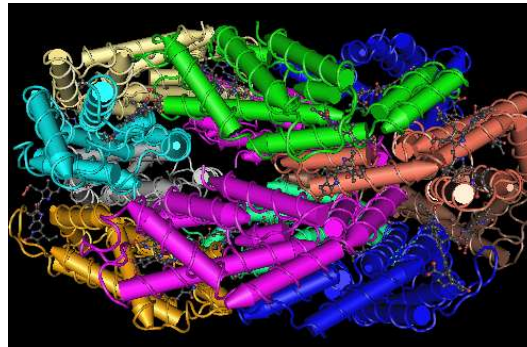


„thermoplastic starch“



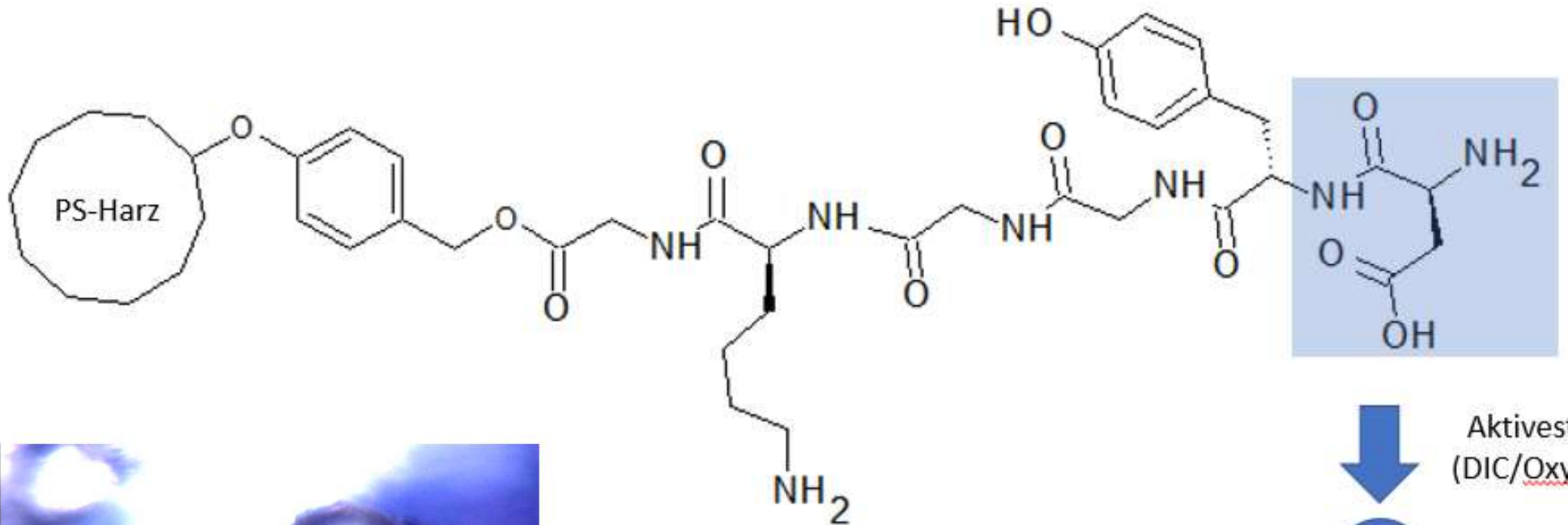
Celluloseacetate

# What in nature ist made of macromolecules?

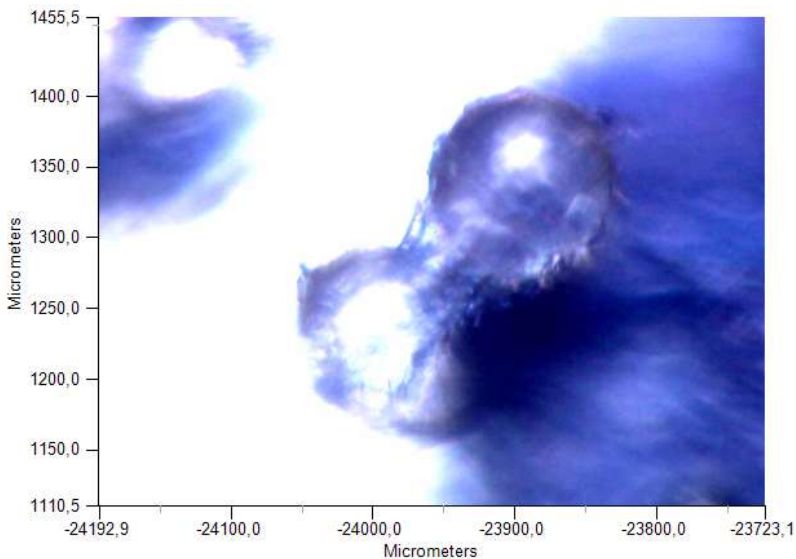


Reference: Photoproma (EFRE-project 2018-2021)

# Modified biogenic macromolecules



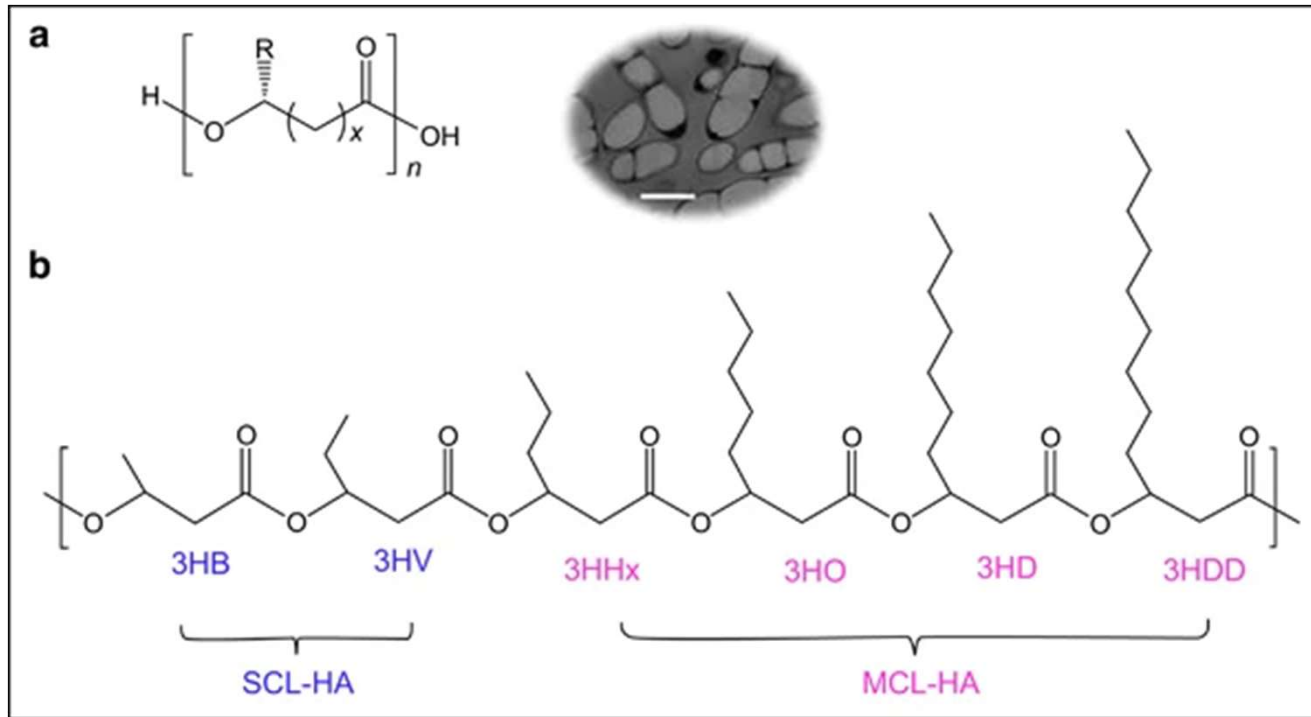
Gly Lys Gly Gly Tyr Asp



Reference: Prof. Dr. Grun / Schmidt



# What in nature ist made of macromolecules?



Quelle:

Li, Z., Yang, J. & Loh, X.

Polyhydroxyalkanoates: opening doors for a sustainable future.

*NPG Asia Mater* **8**, e265 (2016). <https://doi.org/10.1038/am.2016.48>

# T1.1.1 T1.1.1 Synthesis of bio-PES from organic waste-Carbohydrate and recycling sources

Chemical routes – Materials

Recent results and objectives



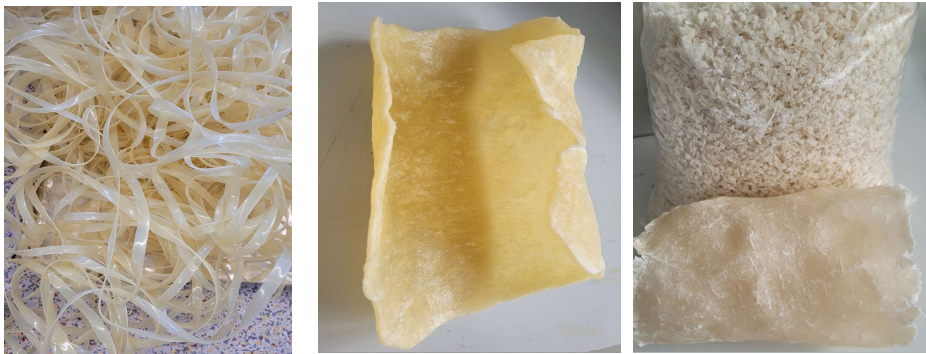
# 1 3 flexibilized PHAs

## PHA materials with various degrees of crystallinity

combining different synthesized PHAs with biogenic PHA materials varies the degree of crystallinity from 17% to 63%.

→ wide range of materials

→ milestone MS1



Sample	Tm °C	Tg °C	Crystallinity %	ts N/mm <sup>2</sup>	eb %
PHB HMW	175	5	63	24	19
PHA.A.3.1.0.1	170,9	0,1	60	49,9	3,1
PHA.A.2.1.0.1	167,2	-10,5	59	62,1	4,4
PHA.A.1.1.0.1	167,6	-15	58	66	4,9
PHA.A.2.1.1.1	169,3	-17,7	55	32,6	2,9
PHA.A.1.1.1.1	169,1	-17,9	54	10,4	4,5
PHA.A.3.1.1.1	174,6	1,1	53	12,8	6,3
PHA.A.3.2.0.1	176,7	-7,4	49	25	130
PHA.A.2.2.0.1	165,9	-21,9	47	28,8	28
PHA.A.1.2.0.1	157,6	-21,7	47	36,1	66
PHA.A.2.2.1.1	165	-20,1	46	10,8	6,5
PHA.A.3.2.1.1	174	-10,9	43	15,9	48
PHA.A.1.2.1.1	163,6	-20,2	43	24,1	17
PHA.A.1.3.0.1	152,3	-44,5	40	13,8	80
PHA.A.3.2.0.1	174,5	-11,2	36	31,1	300
PHA.A.2.3.1.1	156,4	-22,7	33	30,9	88
PHA.A.2.3.0.1	154,7	-28,4	32	14,6	55
PHA.A.1.3.1.1	153,9	-24	32	3,97	36
PHA.A.3.2.1.1	172	-17,1	32	3,05	170
PHA.C.3.1.1.1	159,7	-16,7	31	13	170
PHA.C.3.1.0.1	158,6	-30,3	27	10,3	130
PHA.C.3.2.1.1	161,9	-18,8	26	12	260
PHA.C.3.2.0.1	161,1	-25,2	24	7,84	150
PHA.C.3.3.1.1	152-163,3	-19,4	17	7,54	280
PHA.C.3.3.0.1	164,2	-19	17	4,98	160

# Hermann Staudinger (1881- 1965)

„Father“ of modern Macromolecular Chemistry

Nobel Prize for chemistry 1953

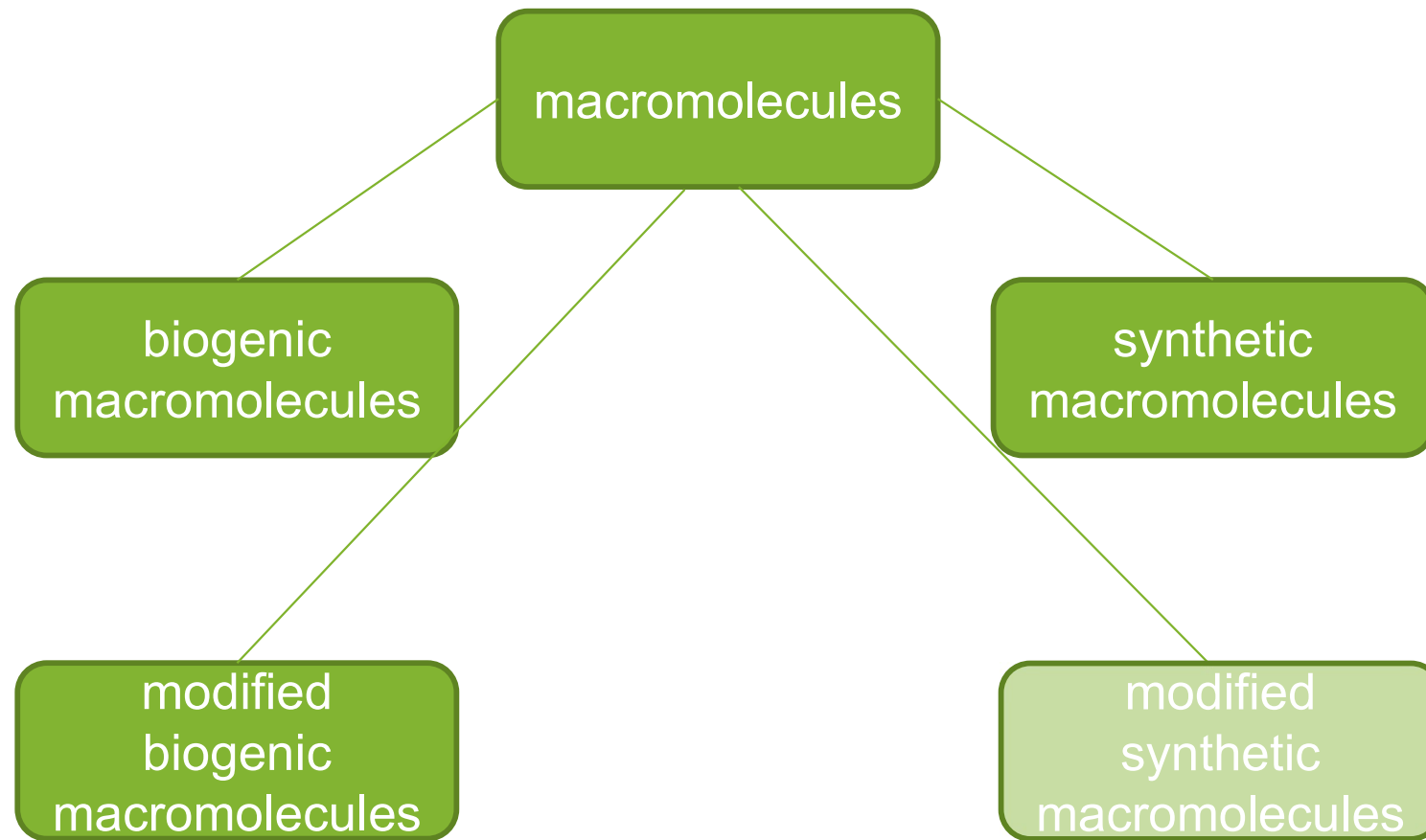


**Hermann Staudinger**

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# Classification of macromolecules



# „Commodities“



Ref.: akcura



© Thomas Seilnacht



Ref.: BIG Spielwarenfabrik



© Thomas Seilnacht

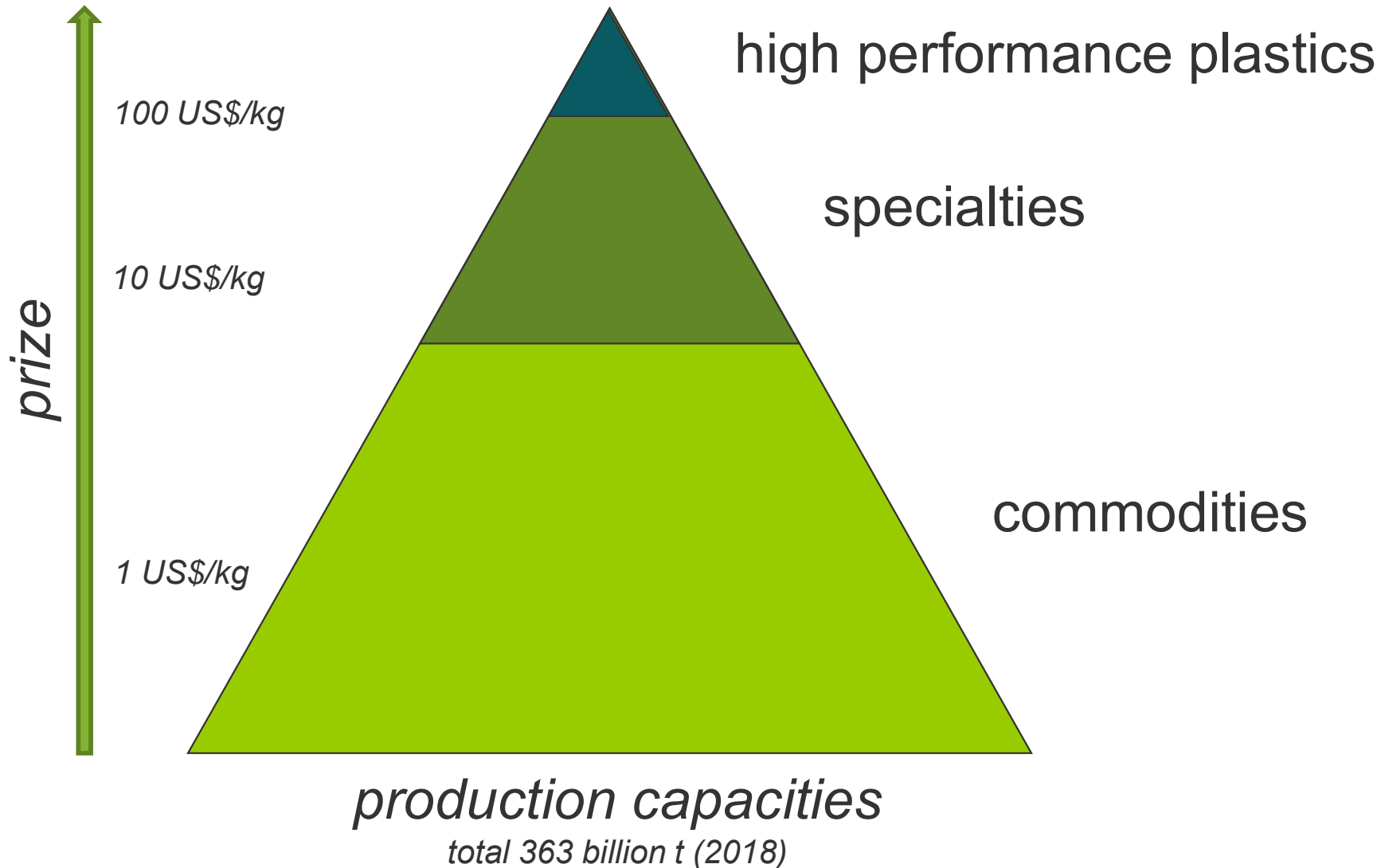
# „specialties and high performance materials“



Airbus-Mitarbeiter fertigen im Werk in Stade Seitenleitwerk-Schalen aus dem neuen Material CFK, einem mit Kohlefasern verstärkten Kunststoff



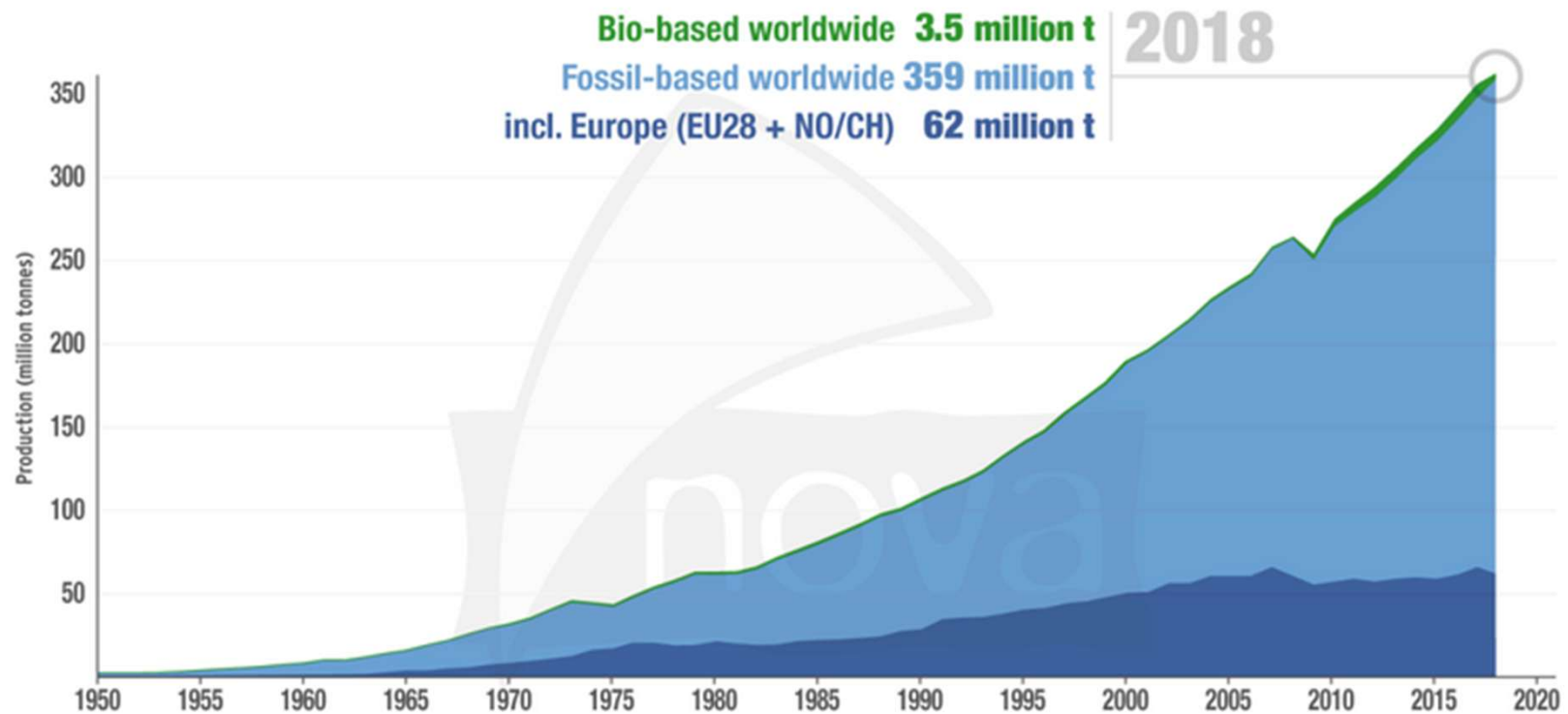
# „commodities, specialties and high performance materials“





# Global production capacities for plastics

## Plastics production from 1950 to 2018



All figures available at  
[www.bio-based.eu/markets](http://www.bio-based.eu/markets)

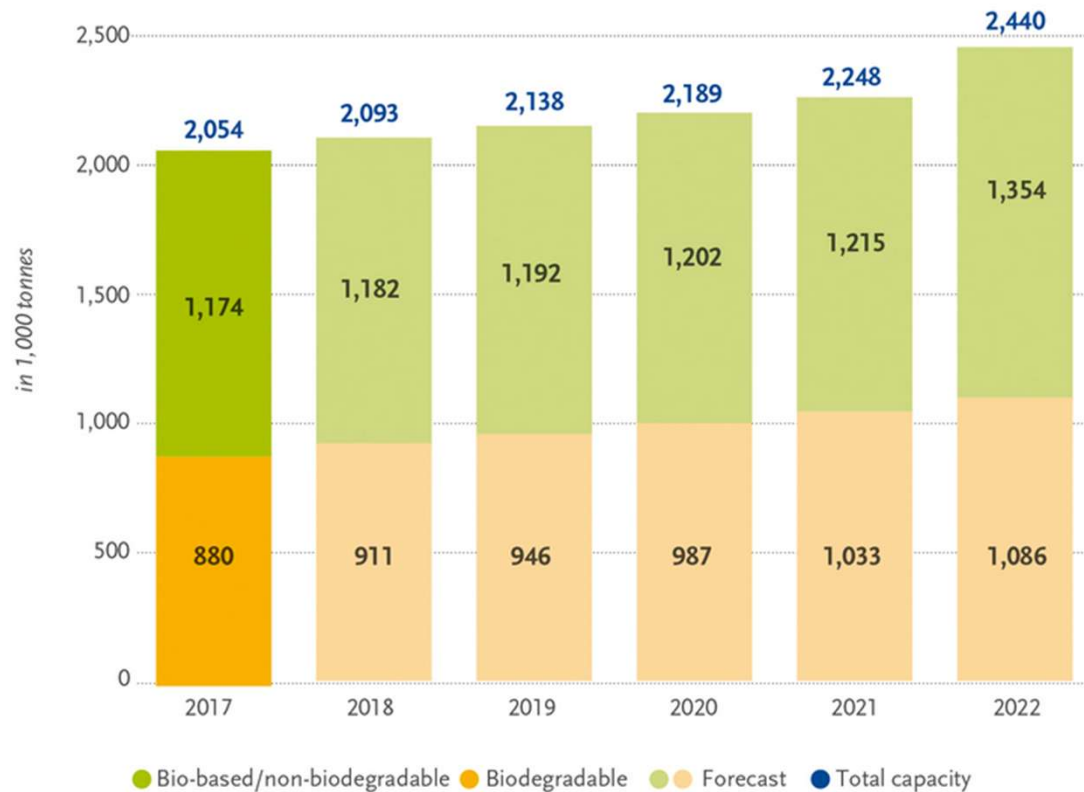
Includes thermoplastics, polyurethanes, thermosets, elastomers, adhesives, coatings and sealants and PP-fibres. Not included PET-, PA-, and polyacryl-fibres.

Data sources: PlasticsEurope, Consultic and nova-Institute


 nova-Institute.eu | 2020

# Global production capacities for bioplastics

*Global production capacities of bioplastics*



Source: European Bioplastics, nova-Institute (2017).  
 More information: [www.bio-based.eu/markets](http://www.bio-based.eu/markets) and [www.european-bioplastics.org/market](http://www.european-bioplastics.org/market)