International Conference on Biological Knowledge Discovery (BKD) in Biotechnology, Bioinformatics and Biomedicine by Gleaning Bioinformation from Biological Data

From data to information to knowledge in Biology

Organized by **Biomedical Informatics (P) Limited** in association with **Muthalammale Arts and Science College**, Thirupanampakkam, Cuddalore, Tamil Nadu-Puducherry (Pondicherry) | **April 15-16, 2026**

Waste Biomass Management: Sustainability through Circular Chemistry and Circular Bioeconomy

Date: April 15, 2026 Wednesday Time: 6.30 PM

Dr. Chinnappan Baskar
Head, Department of Chemistry, **Central University of Kashmir (CUK)**
Visiting Professor, Pattimura University, Ambon, Indonesia
Editor-in-Chief, Encyclopedia of Green Materials, Springer Nature, Singapore

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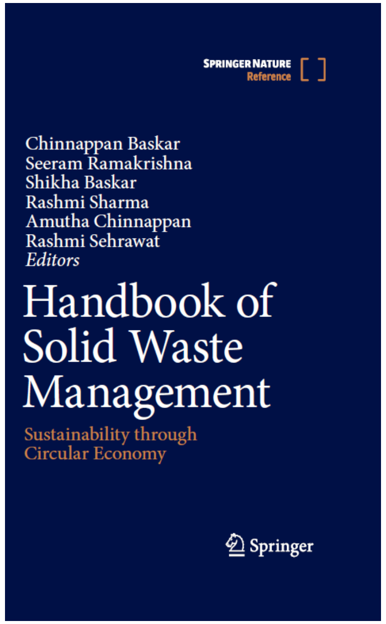
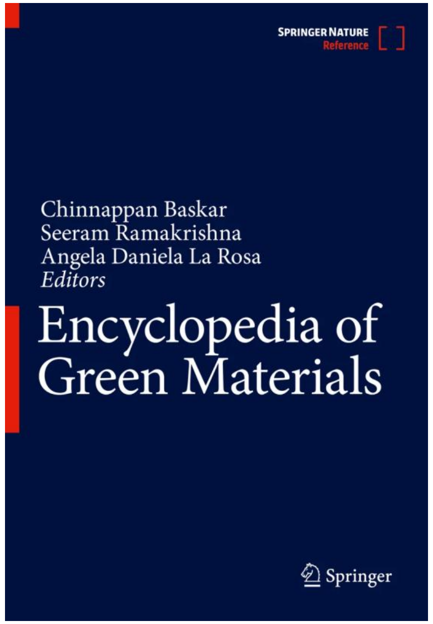
Baskar Website QR

Chemistry Website QR





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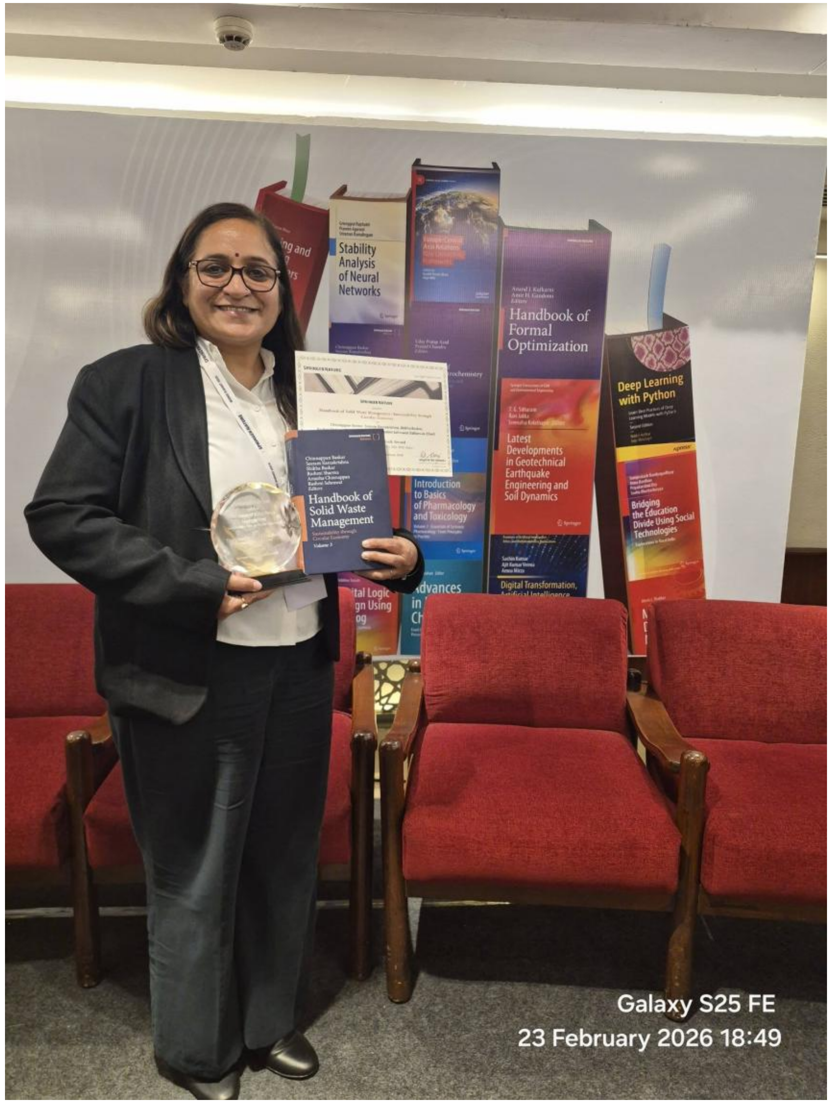

Dr. Shikha Baskar
Associate Dean, Dev Bhoomi Uttarakhand, Dehradun

Prof. Rashmi Sehrawat
Sardar Vallabh Bhai Patel University of Agriculture and Technology, Meerut

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Dr. Benno Boer, Chief of Section- Natural Sciences, UNESCO.

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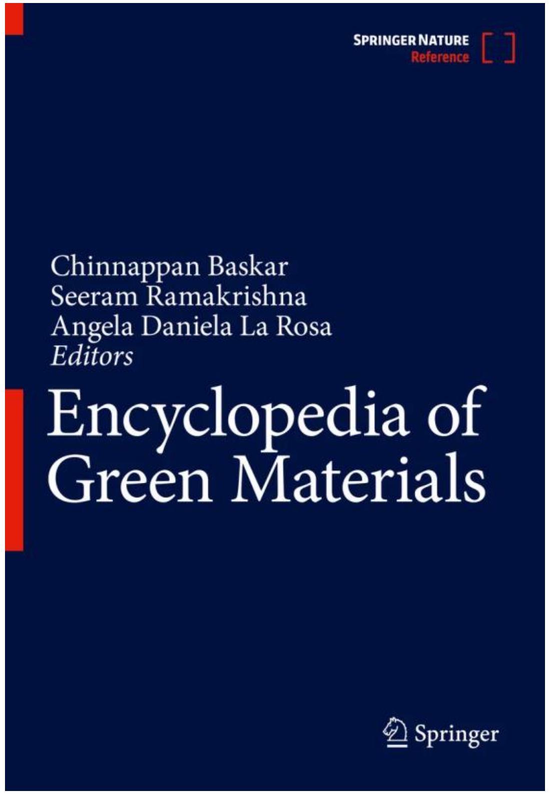
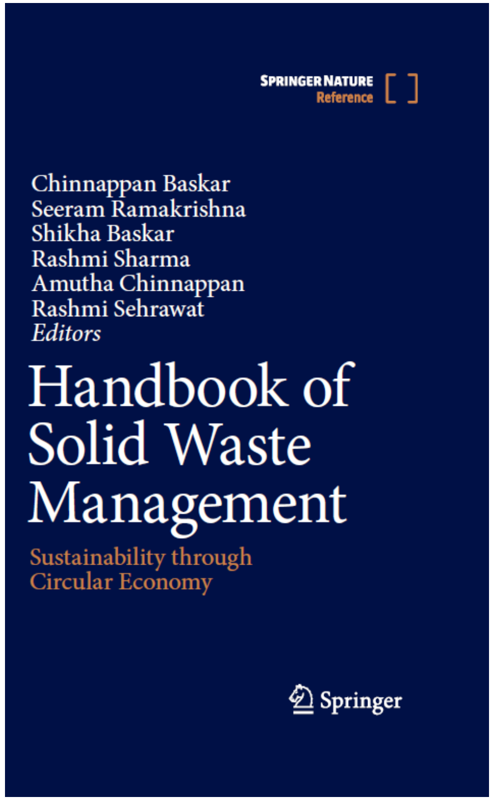


DOI: https://doi.org/10.1007/978-981-97-4618-7

Edition No.: 1; **No. of Volumes:** 3; **No. of pages:** 1950; **Table of Contents** (Total Entries): 867; Print Book Published: Dec 10, 2024 (Price: EUR 649.99); eBook Published: Dec 26, 2024 (Price: EUR 695.49).

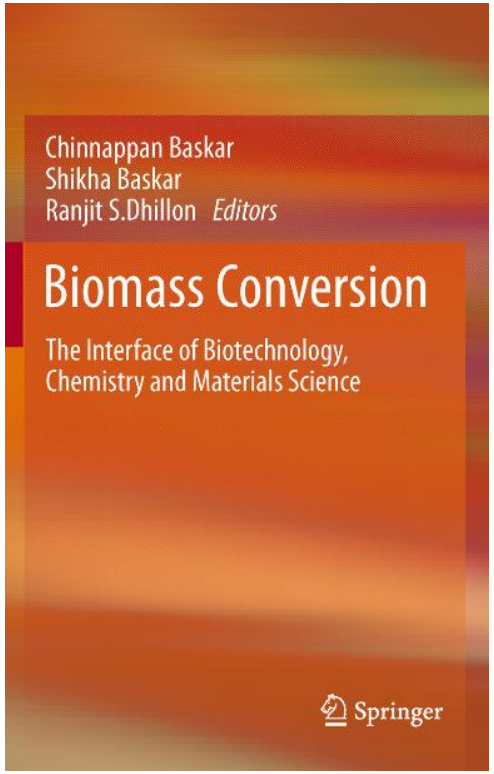
Hardcover ISBN: 978-981-97-4617-0;
eBook ISBN: 978-981-97-4618-7



DOI: https://doi.org/10.1007/978-981-16-4230-2

No. of Volumes: 3; **No. of pages:** 2336; **Part/Section:** I-IV; **No. of Chapters:** 89

Hardcover ISBN: 978-981-16-4229-6 (Published: **05 February 2022**)
eBook ISBN: 978-981-16-4230-2 (Published: 04 February 2022)



DOI: https://doi.org/10.1007/978-3-642-28418-2

Hardcover ISBN: 978-3-642-28417-5 (Published: 09 May 2012)
eBook ISBN: 978-3-642-28418-2 (Published: 08 May 2012)
Softcover ISBN: 978-3-642-44449-4 (Published: 11 June 2014)
Number of Pages: XXVIII, 468

Dr. Chinnappan Baskar | Academic Chronology

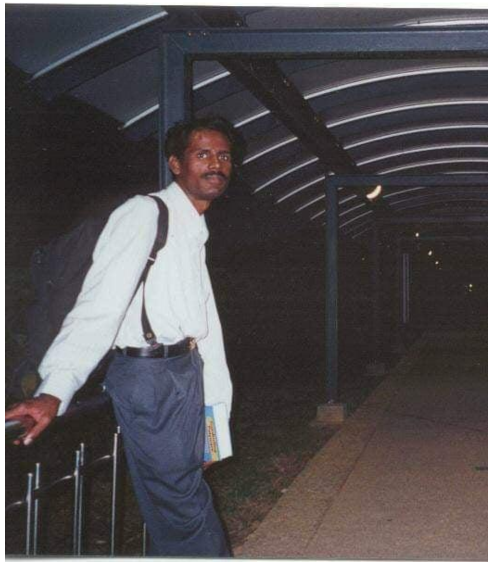
- **Associate Professor and Head**, Department of Chemistry, **Central University of Kashmir (Ministry of Education, Govt. of India)**, Ganderbal, Jammu and Kashmir, India (Since Feb 19, 2024)
- **Professor and Director**, Himalayiya University (*now* Sparsh Himalaya University), Dehradun, Uttarakhand (April 2022-Jan 2023)
- **Visiting Professor**, Pattimura University, Ambon, Indonesia (Since Oct 2020)
- **Professor and Director (Research and Development)**, Teerthanker Mahaveer University, Moradabad, Uttar Pradesh (Feb 2019-Oct 2020)
- **Associate Professor and Former Director (Officiating)**, **THDC Institute of Hydropower Engineering and Technology, Tehri**, Constituent Institute of Uttarakhand Technical University, Dehradun (June 2011-Feb 2019)
- **Director (Academic Affairs)**, Dev Bhoomi Group of Institutions, Dehradun (Sep 2010-May 2011)
- **BK21 Research Professor**, Department of Environmental Engineering and Biotechnology; Energy and Environment Fusion Technology Center, **Myongji University**, South Korea (Sep 2009-Aug 2010)
- **Assistant Professor and Head**, Department of Chemistry, Lovely Professional University, Phagwara, Jalandhar (Aug 2006-Aug 2009)
- **PhD** in Organic and Materials Chemistry, **National University of Singapore (NUS)**, Singapore (1999-2004)
- **M. Sc. Chemistry**, **Indian Institute of Technology (IIT) Madras**, Chennai, Tamil Nadu, India (1995-1997)
- **Author/President**, **YSB Foundation**, Public Charitable Trust, Uttarakhand, India (Since Sep 24, 2018)

EDUCATE ★ ENRICH ★ EMPOWER

Teaching

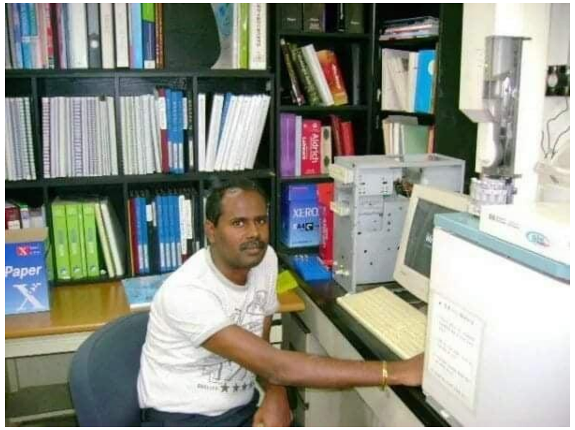
Research

Administration



Student Life
(PhD at NUS Singapore)

Director (Officiating)
THDC Institute

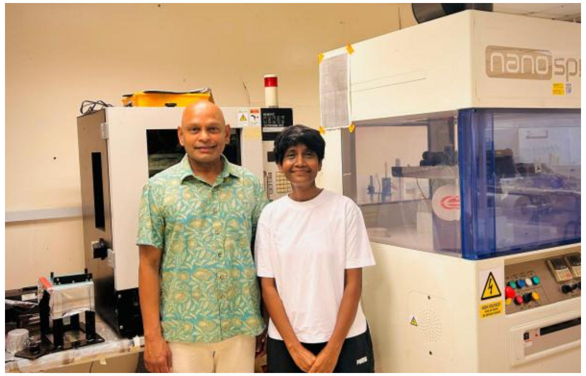


BK 21 Research Professor
South Korea

"To make promise into reality, we need **commitment.**" - **Chinnappan Baskar** © 2004

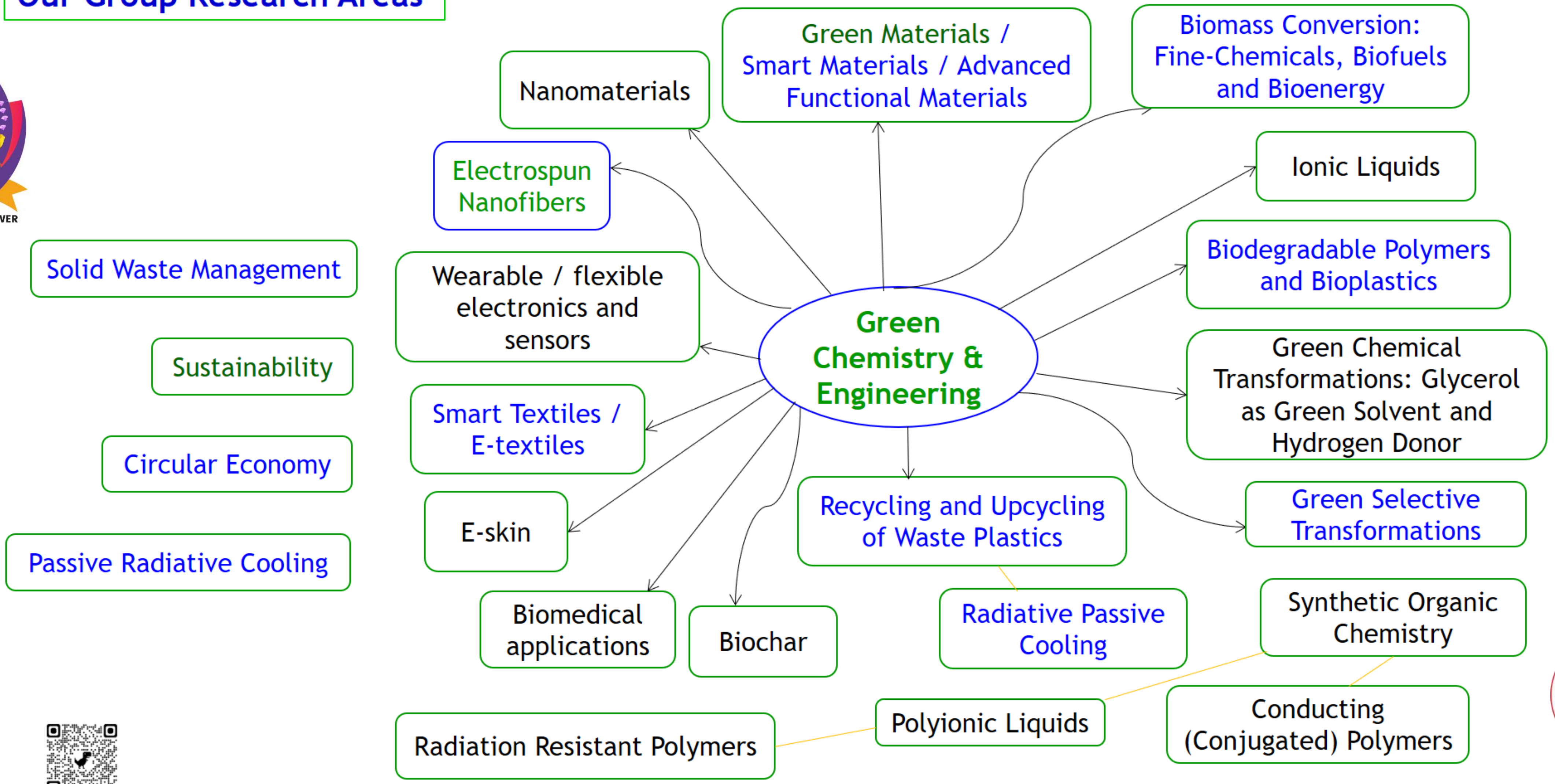
Prof. Seeram Ramakrishna
Tsinghua University, China
Former Director, Center for Nanofiber and Nanotechnology, Department of Mechanical Engineering
National University of Singapore (NUS)

Dr. Amutha Chinnappan
Institute for Frontier Materials
Deakin University, Australia
Former Research Fellow, Center for Nanofiber and Nanotechnology, Department of Mechanical Engineering, **NUS**



Dr. Shikha Baskar
Associate Dean, School of Allied Sciences
Dev Bhoomi Uttarakhand University, Dehradun

Our Group Research Areas

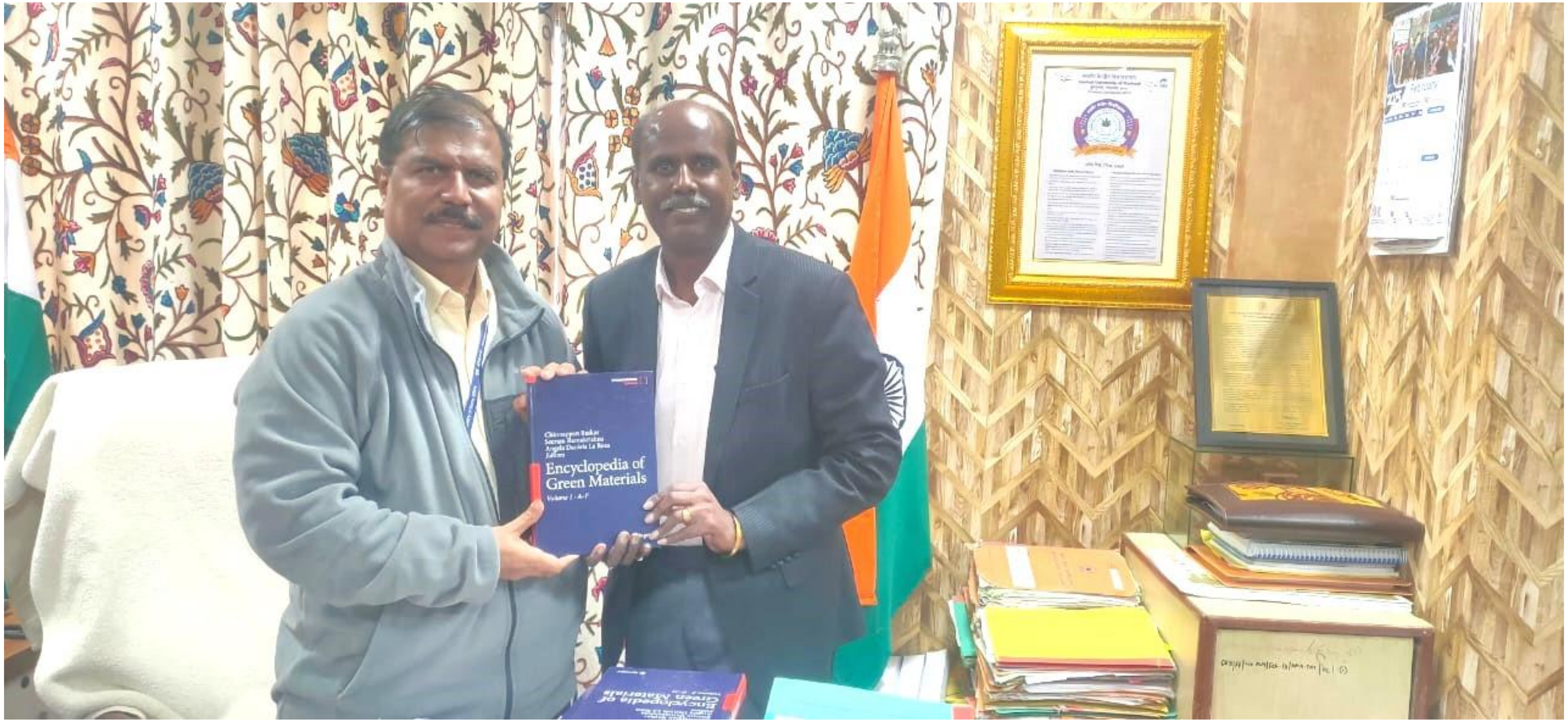


Our Group Research and Development

Title: Conversion of Biomass into Biodegradable Plastics and their Applications

- **Grantor**: DST, Govt of India
- **Value:** 34.66498 Lakh
- **PI: Dr. Shikha Baskar, Scientist, Chemistry Division, FRI Dehradun**

The **Department of Chemistry** at the Central University of Kashmir has a vibrant hub of academic excellence, interdisciplinary research and innovation. The Department has a Master's Program in Chemistry with specializations in Organic, Inorganic and Physical Chemistry. The Department operates currently from the Science Campus in Nunar, Ganderbal, Jammu and Kashmir, and is led by **Dr. Chinnappan Baskar**, a distinguished academic and researcher, under the mentorship of the **Hon'ble Vice Chancellor, Prof. A. Ravinder Nath**, Central University of Kashmir. The faculty comprises nine young, dynamic, and highly qualified members trained at premier institutes in India and abroad, bringing global perspectives into teaching and research.



- **M. Sc Chemistry** (30 Admission through CUET)
- **B. Sc Chemistry (Honors/Honors with Research)** [4-year UG] [30 Admission through CUET]
- **PhD** [Vacancy: 14]
- Upcoming New Programs: **Apprenticeship Embedded Degree Program (AEDP)**

Department of Chemistry, Central University of Kashmir, Ganderbal, Kashmir

INSTRUCTION FOR FOUR YEAR UNDERGRADUATE PROGRAM (FYUGP)
B. Sc Chemistry (Honors) and B. Sc Chemistry (Honors with Research)
[As per the Curriculum and Credit Framework for Undergraduate Programs (**CCFUP**); National Credit Framework (**NCrF**); National Higher Education Qualifications Framework (**NHEQF**); National Education Policy (**NEP**) 2020 and follow a **Multiple Entry Multiple Exit (MEME) Framework**]

Program for the Academic Session 2026-27: B. Sc Chemistry Program with Single Major

S. No.	Program/ Degree	Duration	Total Credits	Proposed Students Intake
1	**B. Sc Chemistry**	3-year UG	120	**30**
2	**B. Sc Chemistry (Honors)**	4-year UG	160	
3	**B. Sc Chemistry (Honors with Research)**	4-year UG		

These programs are designed in line with the Curriculum and Credit Framework for Undergraduate Programs (**CCFUP**); National Credit Framework (**NCrF**); National Higher Education Qualifications Framework (**NHEQF**); National Education Policy (**NEP**) 2020 and follow a **Multiple Entry Multiple Exit (MEME) framework**. Students have the flexibility to exit after one year with a **Certificate**, after two years with a **Diploma**, or after three years with a **Bachelor's degree**. Those who complete the full four years will be awarded an **Honors degree/Honors degree with Research**.

S. No. (C-1)	Program/ Degree (C-2)	Duration (C-3)	Credits per year (C-4)	Total Credits (C-5)	Common National Credit Framework Level (C-6)	Credit Points earned (C-7 = C4xC6)
1	UG Certificate	1-Year UG	40	**40**	4.5	180
2	UG Diploma	2-Year UG	40	2x40=**80**	5.0	200
3	**B. Sc Chemistry**	3-year UG	40	3x40=**120**	5.5	220
4	**B. Sc Chemistry (Honors)**	4-year UG	40	4x40=**160**	6.0	240
5	**B. Sc Chemistry (Honors with Research)**	4-year UG	40	4x40=**160**	6.0	240

C-Column

The four-year Honors degree offers considerable academic advantages, including eligibility for direct admission to PhD programs and the option to pursue a one-year postgraduate degree, replacing the traditional two-year model.

Page **3** of **65**
FYUGP | Head & Chair, BOS, Chemistry | Dean Academic Affairs | Vice Chancellor

Demand of Circular Economy Approaches for Solid Waste Management | Dumping yard, Eidgah Syed Pora, Srinagar, Kashmir | October 13, 2025

Need of Solid Waste Management Solutions: Circular Economy Approach | Bhagtanpur Abidpur Urf Ibrahim, Haridwar, Uttarakhand | Oct 1, 2025

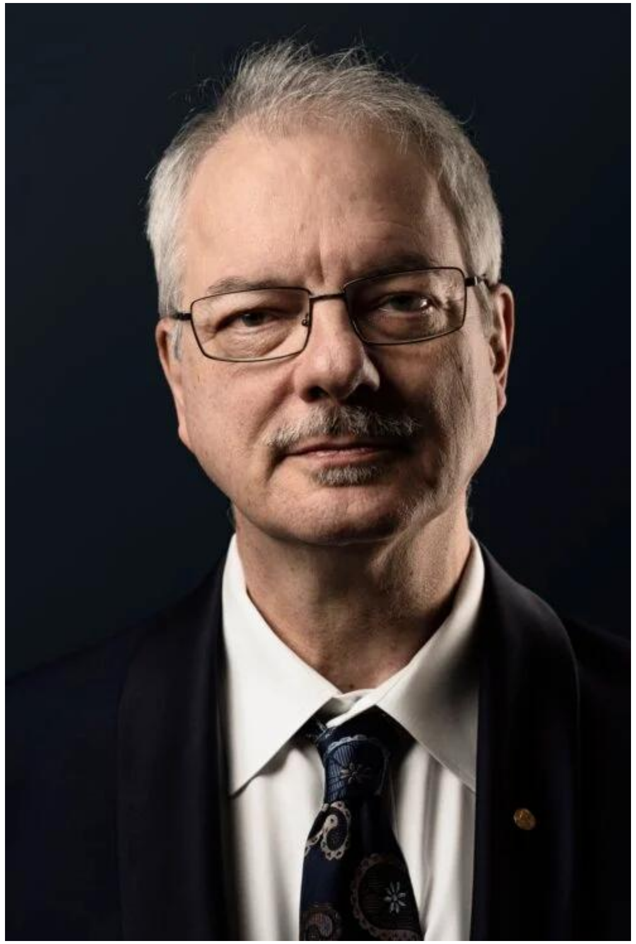
EDUCATE ★ ENRICH ★ EMPOWER

BinGo Ecosystem: Toss your trash, Keep the Cash

BinGo Ecosystem | Founder: Suvir Baskar and Yavin Baskar
https://www.youtube.com/watch?v=izZYUxvlI_c

Please Subscribe, like, comment and share the link to your friends and your networks.

Suvir Baskar joined the **Blue Ocean Student Entrepreneur Competition 2026**
https://blueoceancompetition.org/



"I am **chemistry**, you are **chemistry**. All our surroundings are **chemistry**. We will need **chemistry** very much to solve all the global challenges ahead of us. We need **chemistry solutions** and for our **young people** to learn about **chemistry**."

- **Morten Meldal** (Nobel Prize in Chemistry 2022)

The **Nobel Prize in Chemistry 2022** was awarded jointly to **Carolyn R. Bertozzi**, **Morten Meldal** and **K. Barry Sharpless** "for the development of **click chemistry** and bioorthogonal chemistry"

https://www.nobelprize.org/prizes/chemistry/2022/meldal/facts/

“**Discovery** consists of seeing what everybody has seen and thinking what nobody else has thought."

– **Albert Szent-Gyorgyi**

"**The most powerful force** for all **success is LOVE**.“

– **Chinnappan Baskar** © 2004

"**Chemistry** is physics without thought; mathematics is physics without purpose." – **Anonymous**

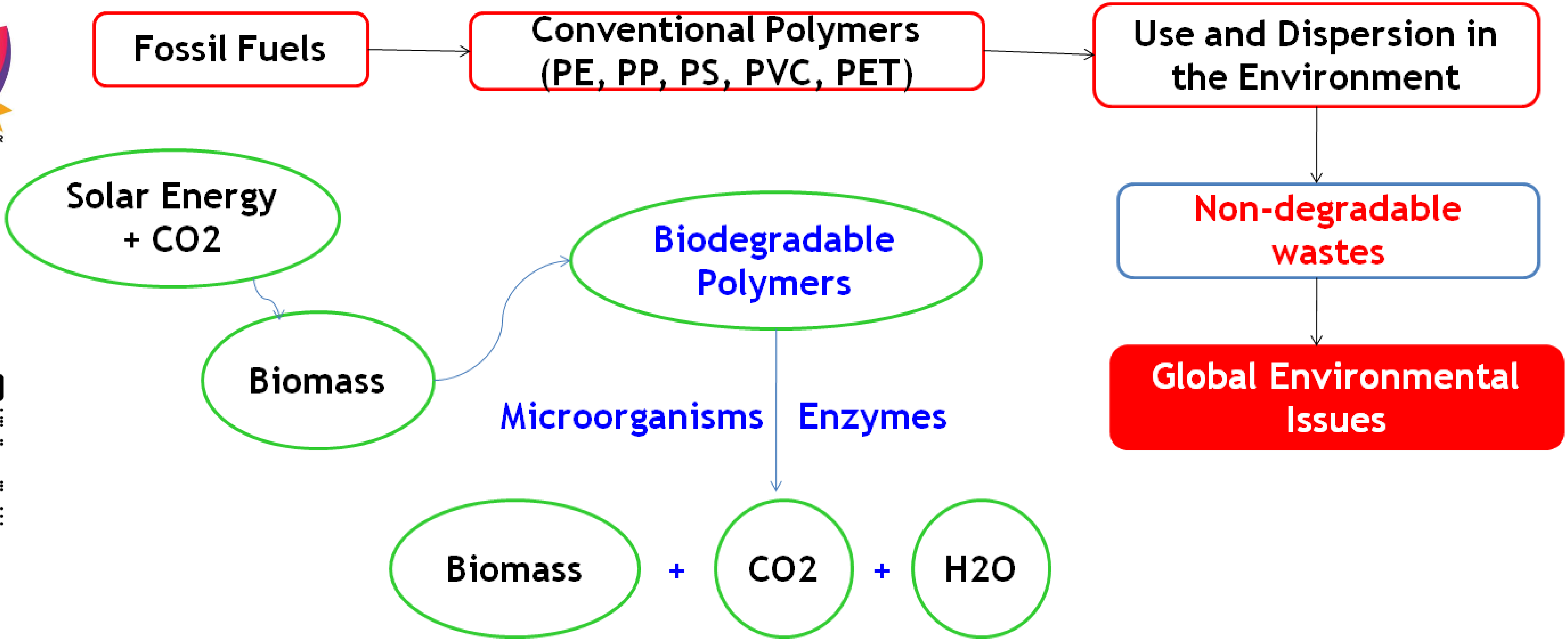
❖ **Discovery**

❖ **Invention: Creating something new**

❖ **Innovation: Creating something new with new value**

Be open to Learn, Unlearn and Relearn

Why Green Materials / Green Polymers / Biodegradable / Sustainable Polymers Required?

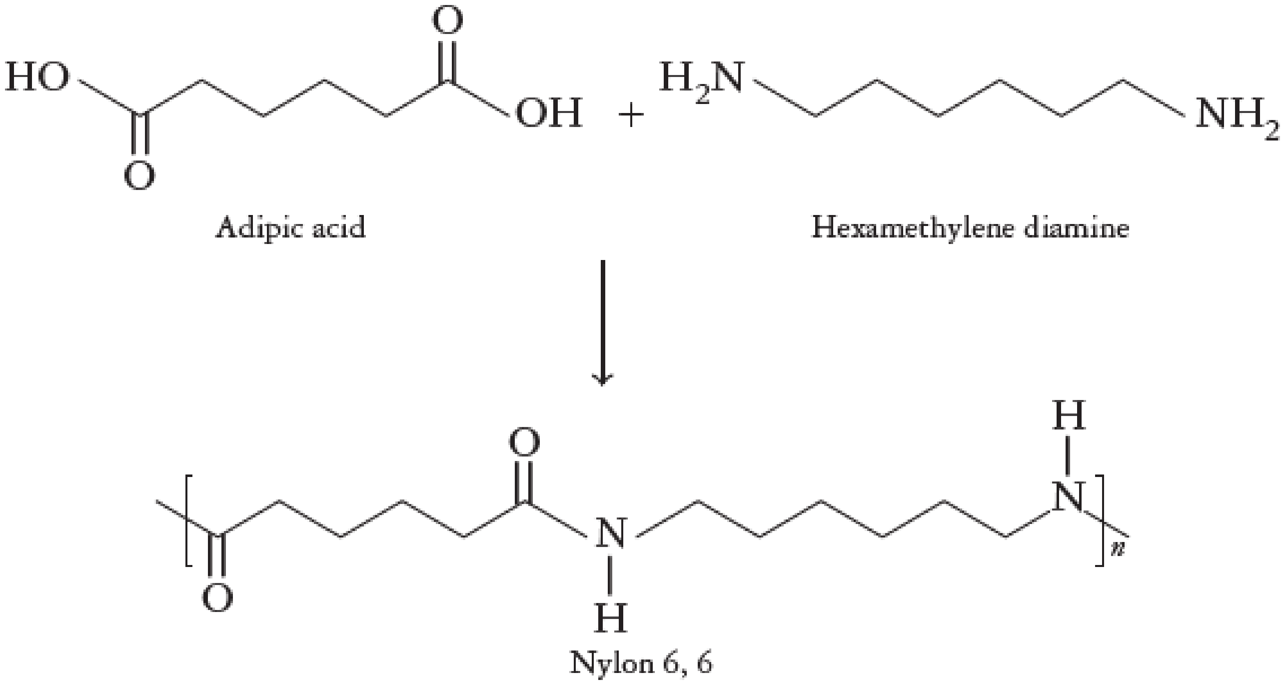


Natural Polymers to Synthetic Polymers

Nylon

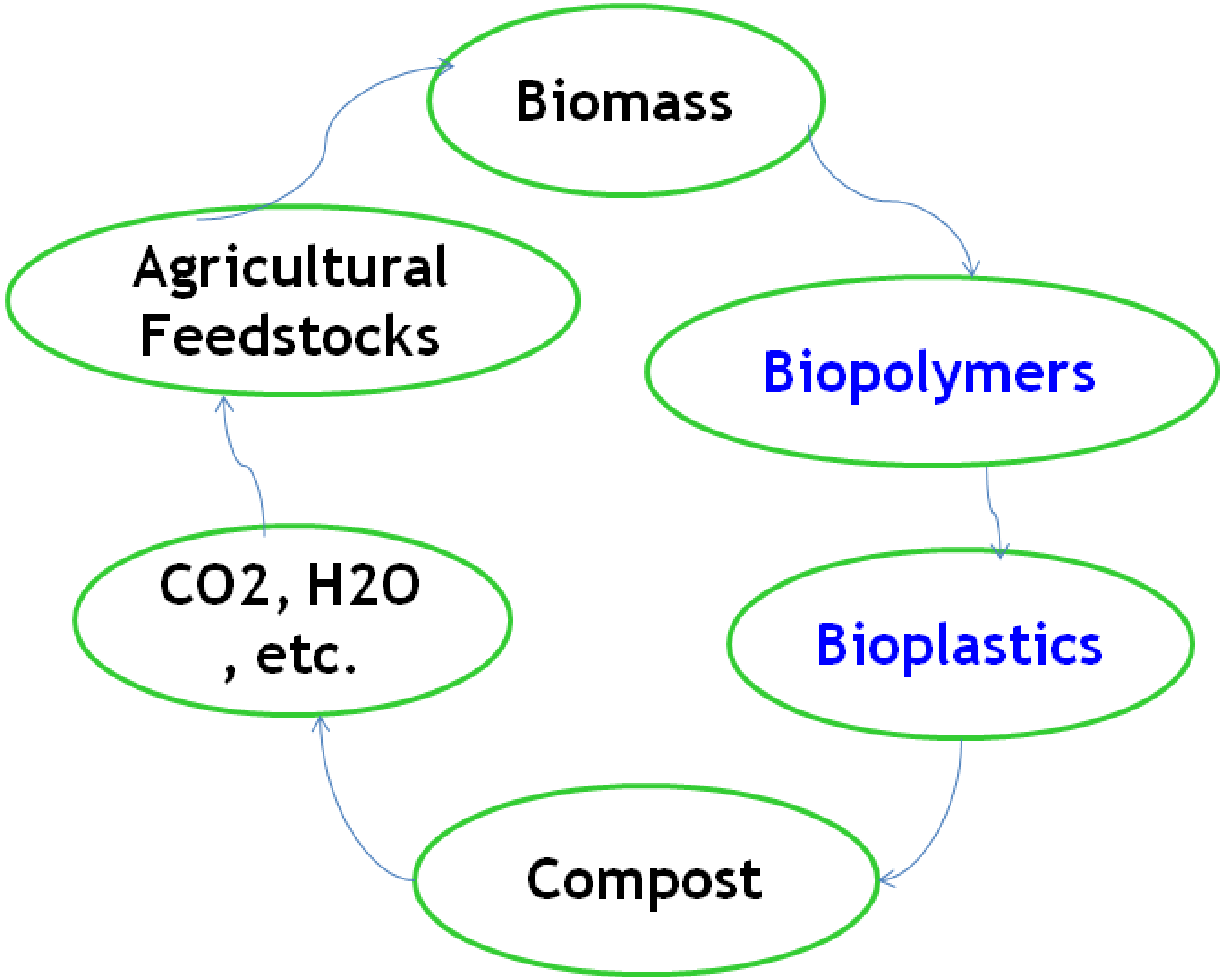
Synthetic Polymers

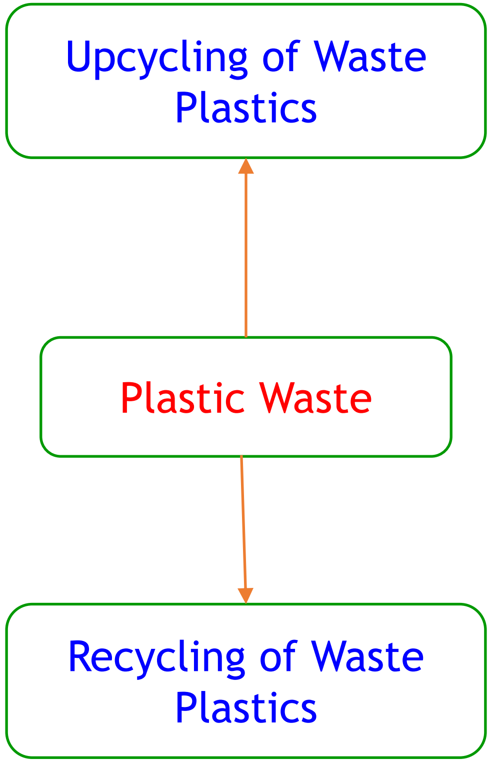
Political events of the 1930s created an interesting **crisis in fashion**. **Women wanted <u>sheer stockings</u>**, but with the growing **unrest** in the world, manufacturers were having an increasingly difficult time obtaining the **silk** necessary to make them. **Chemistry came to rescue**.



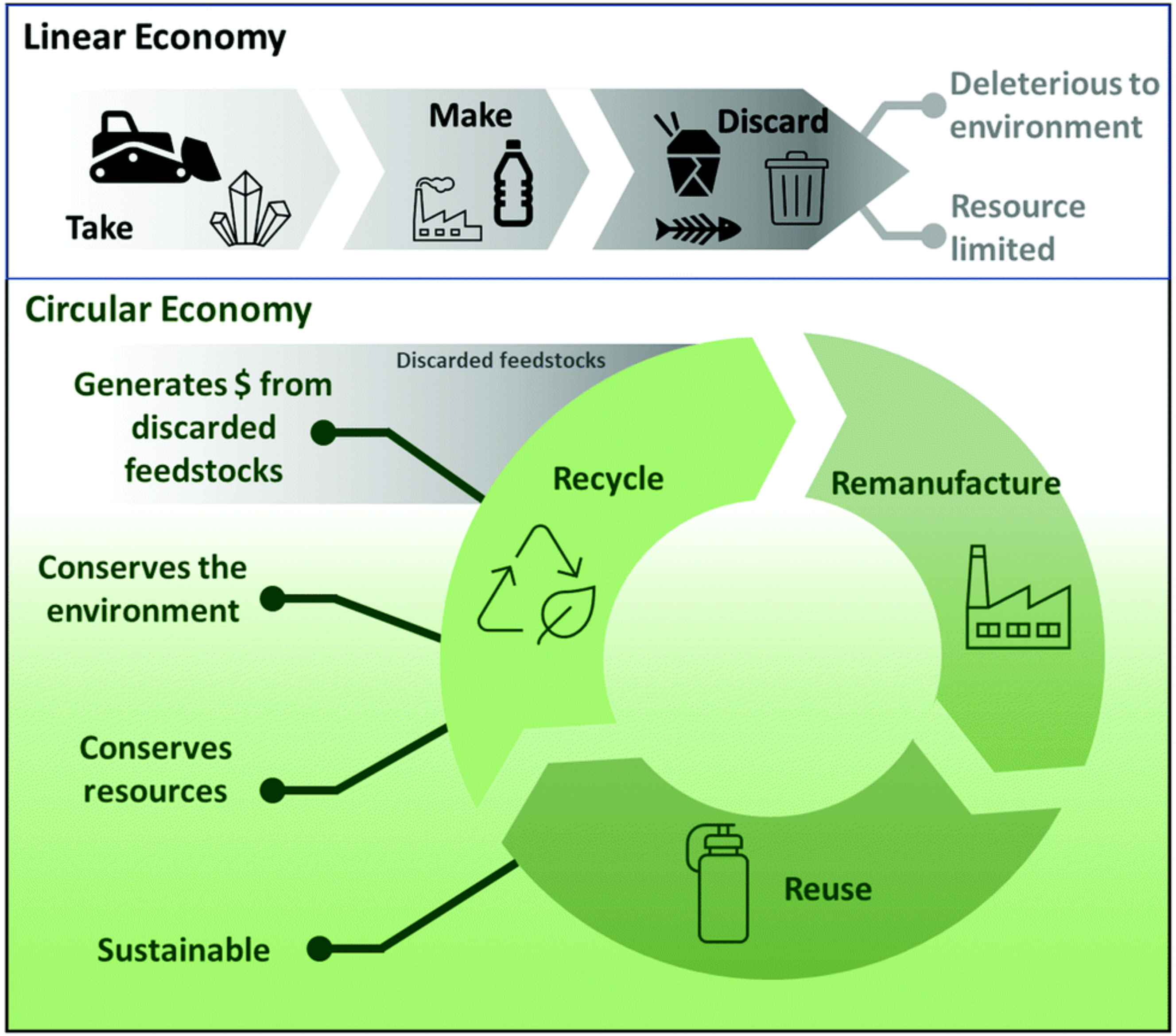
Nylon 6, 6 by Wallace Hume Carothers at DuPont's (Feb 28, 1935)

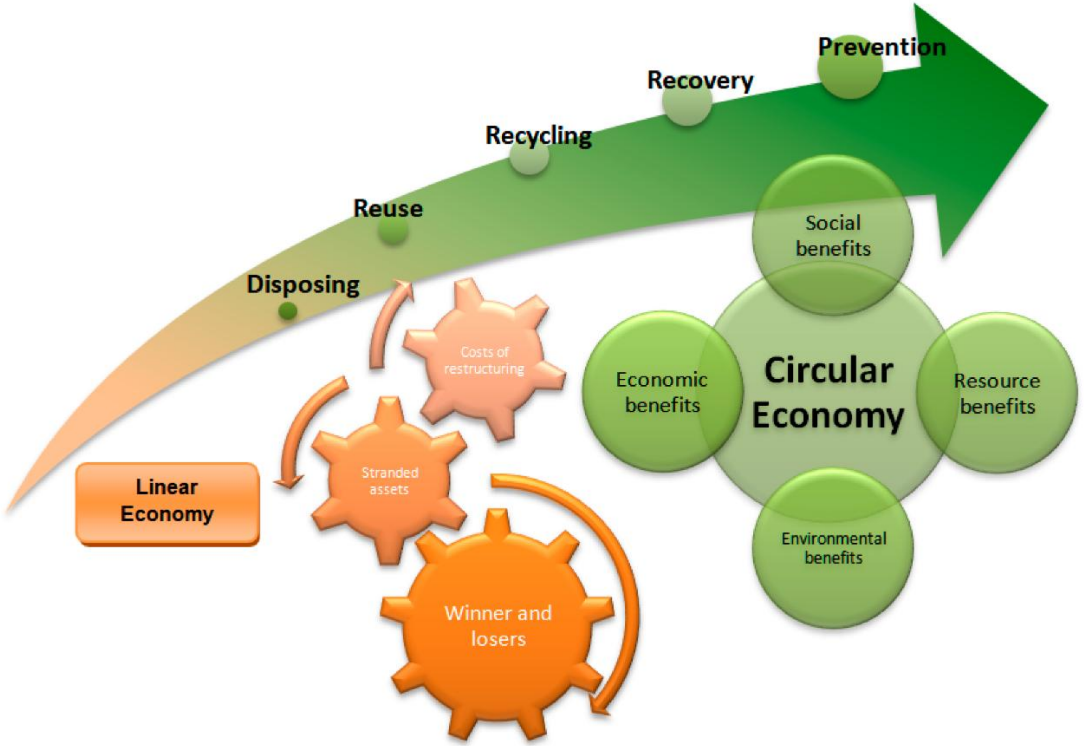
Why Green Materials / Green Polymers / Biodegradable / Sustainable Polymers Required?





Linear Economy and Circular Economy





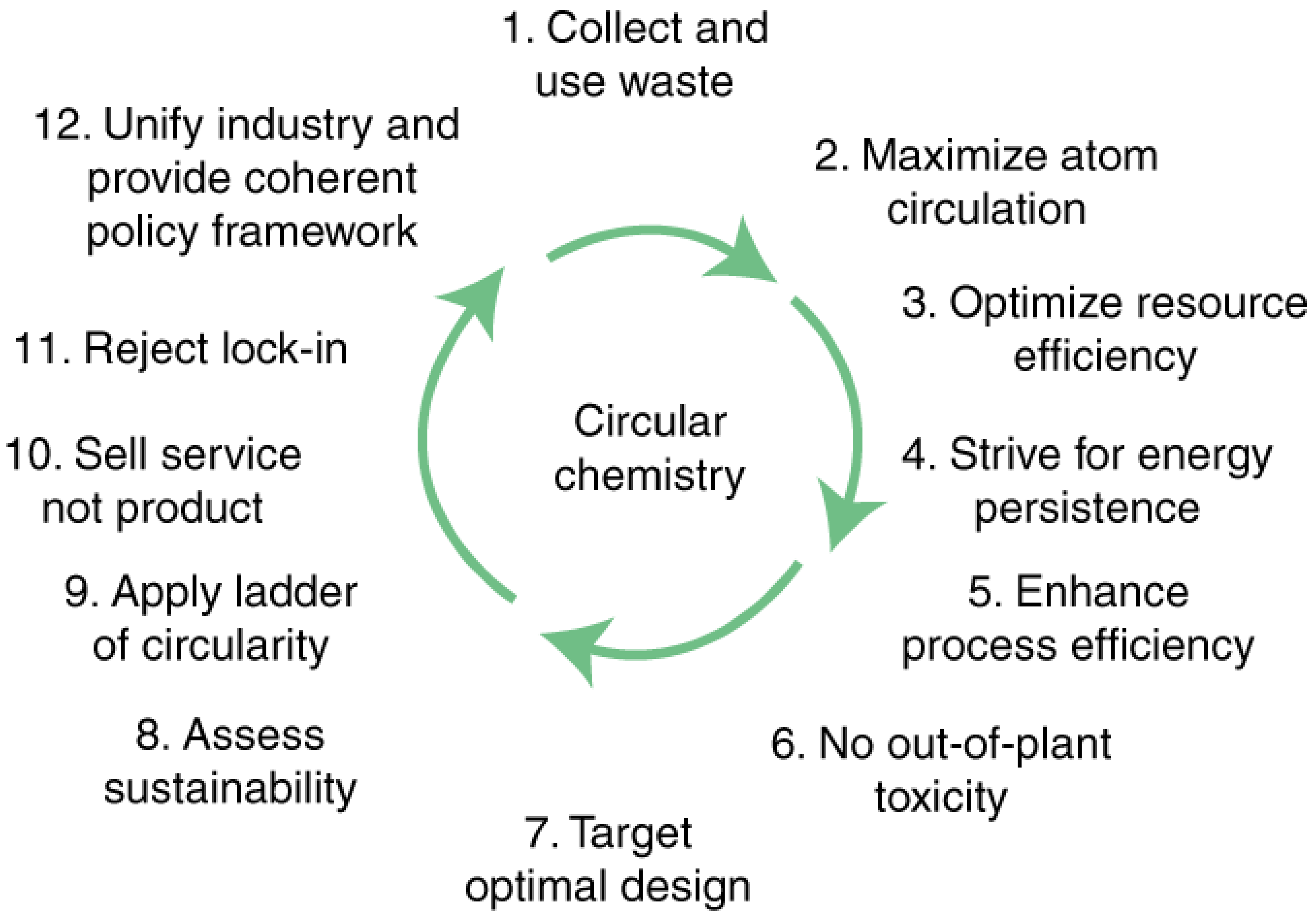
Linear Economy "take-make-waste" system to **Circular Economy** system (**6Rs**: **Rethink, Refuse, Reduce, Reuse, Repair and Recycle**).

Int. J. Environ. Res. Public Health 2019, 16, 2234
doi:10.3390/ijerph16122234

Mater. Adv., 2021, 2, 1113; DOI: 10.1039/d0ma00689k

Circular Chemistry to enable a Circular Economy

The Twelve Principles of Circular Chemistry



Nature Chem **2019,** *11*, 190–195
https://doi.org/10.1038/s41557-019-0226-9

Circular Bioeconomy: What it means and how to get there

- The **bioeconomy** refers to an **economy where the basic building blocks for industrial materials, chemicals and energy** are derived from **renewable biological resources** such as **trees, plants, animals and microorganisms** and their by-products (BBIA, 2025).

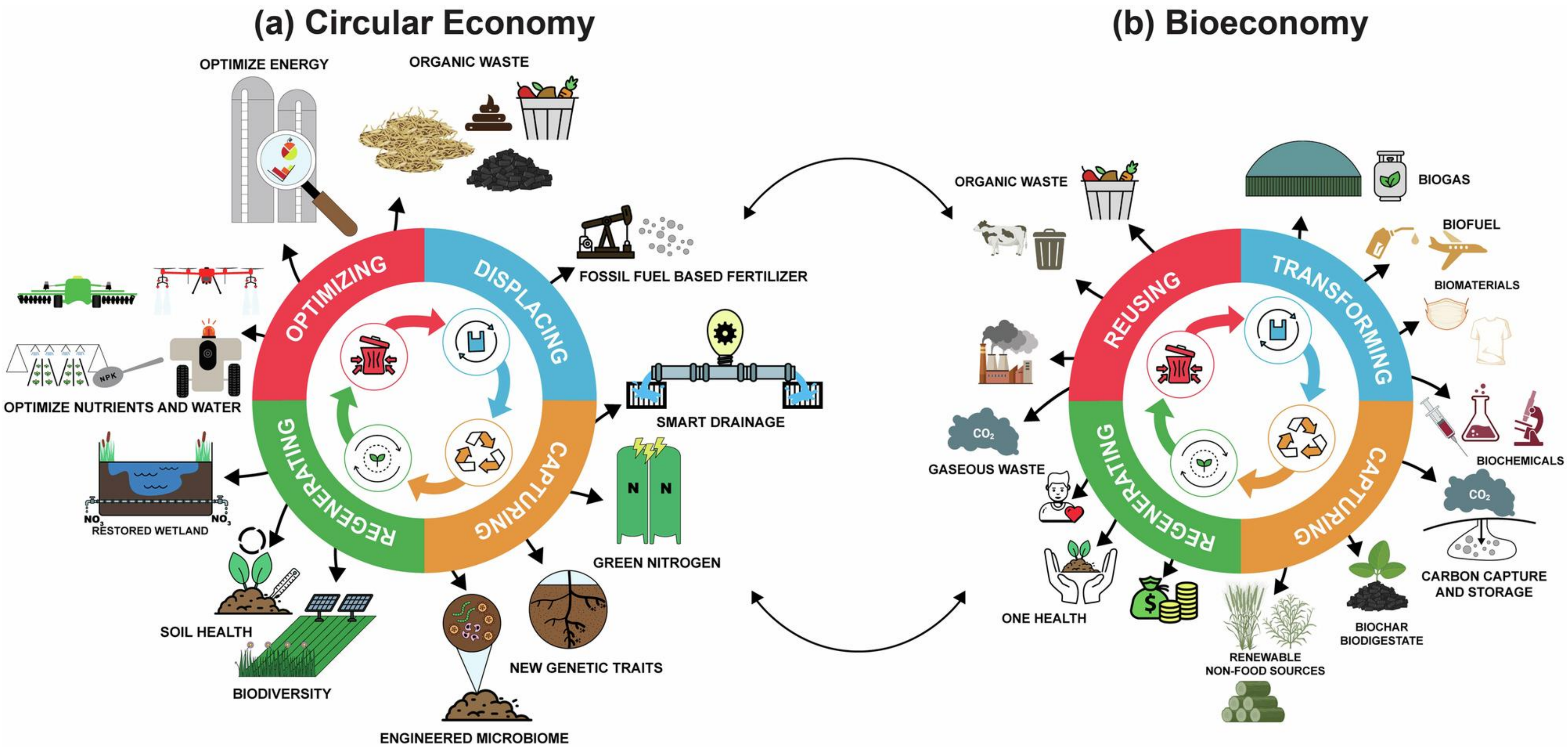
- By **integrating** the **circular economy** and the **bioeconomy**, countries can power development, **curb waste** and use **natural resources** more sustainably.

Some agricultural waste like maize husks can be used as a natural fibre for textiles, paper and in various industrial processes.

https://unctad.org/news/circular-bioeconomy-what-it-means-and-how-get-there

https://www.socialnews.xyz/2026/04/01/india-turns-crop-waste-into-roads-with-breakthrough-bio-bitumen-technology/

https://www.linkedin.com/posts/medc-india_greeninfrastructure-sustainableroads-biobitumen-activity-7419341143026577409-57wj/



(a) represents **multiple pathways to reduce, recycle and reuse waste in a circular economy**; (**b**) represents **multiple pathways to produce inputs, food and energy products in a bioeconomy**. Together, the two panels show the interconnections among the pathways to reduce, recycle and reuse waste and to convert unavoidable waste and other biological resources to bioproducts that displace fossil fuels.

https://www.nature.com/articles/s43247-024-01663-6/figures/1

Integrated Solid Waste Management: Waste to Wealth through Circular Chemistry and Circular Economy | Start-ups Projects: Mini Scale | Micro Scale | Large Scale

- **Biogas from Solid Waste**
- Plastic Waste Recycling
- Waste Cloth Recycling
- Paper Recycling
- **Sanitary Pad Waste Recycling**
- Solid Waste to Energy
- Solid Waste to Value Added Products
- Waste to Road Construction

- **Food Waste to Biogas**
- **Agricultural Waste** to Value Added Products
- Green Hydrogen from Solid Waste
- E-waste Recycling
- Recycling of cans and steel
- Rubber Waste Recycling
- Glass Recycling
- Medical Waste

- **Green Chemistry:** According to the International Union of Pure and Applied Chemistry (IUPAC), **green chemistry** is closely related to the "**design of chemical products and processes that particularly eliminate the use or generation of substances hazardous to humans, animals, plants, and the environment**". In other words, the concept of green chemistry addresses the problem of chemical pollution and refers to the design of chemicals and their production processes reducing or eliminating the use or generation of hazardous substances. Green chemistry is centered around twelve principles (see Section 2.1) which describe how a chemical should be produced, and used in a clean and green way reducing the material use and pollution of the environment.

- **Sustainable Chemistry:** Although the concept of **sustainability** was first introduced by Hans Carl von Carlowitz (1645–1714), the term sustainable chemistry was defined by The Organisation for Economic Co-operation and Development (OECD) in the 1990s as "**a scientific concept that seeks to improve the efficiency with which natural resources are used to meet human needs for chemical products and services**". Based on this definition, **sustainable chemistry is closely related to the twelve principles of green chemistry**, as sustainable chemistry prioritizes production processes that promote increased product value while intersecting the goals of protecting and enhancing human health and the environment. The concept of sustainable chemistry is also reflected in the Sustainable Development Goals of the United Nations—especially in Goal 12 "**Responsible Consumption and Production**," which highlights the importance of "decoupling economic growth from environmental degradation, increasing resource efficiency, and promoting sustainable lifestyles."

- **Circular Economy and Circular Chemistry:** "**Waste," the result of the linear "take-make-use-dispose**" economy, commonly refers to man-made materials that are "**thrown away**" – either collected as "trash" or landfilled or discarded in the environment – as materials without economic value or even with negative economic cost (e.g., landfill fees). Nevertheless, since matter can be neither created nor destroyed (Law of Conservation of Matter), the option to "throw away" is not feasible in the long term within a system. Accordingly, anthropogenic waste in all its forms is substantially contributing to a range of planetary-scale environmental crises that are evolving with escalating speed. In 2009, Rockström et al. introduced the Planetary Boundaries framework defining nine interlinked planetary boundaries, i.e., climate change, ocean acidification, stratospheric ozone depletion, biogeochemical flow, global freshwater use, change in land use, biodiversity loss, atmospheric aerosol loading, and chemical pollution/novel entities.

Macromol. Chem. Phys. **2022,** *223*, 2200111
https://doi.org/10.1002/macp.202200111

Green Chemistry and Engineering

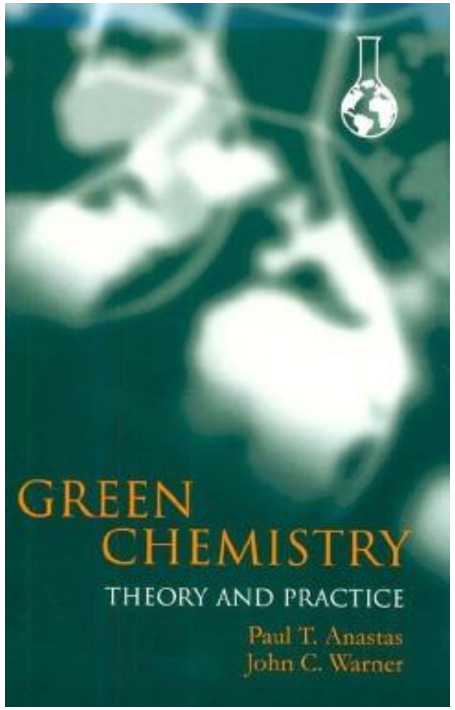
- Green Chemistry differs from conventional chemistry in several different categories including nature of starting materials, reagents, reaction conditions and target molecule.

- Green Chemistry is an integral part of Green Engineering. The definitions share common language, and the application of both chemistry and engineering principles is needed to advance the goals of sustainability.

- *Green Chemistry*: The design of chemical products and processes that reduce or eliminate the use and generation of hazardous substances.

- *Green Engineering*: The design, commercialization, and use of processes and products that are feasible and economical while minimizing pollution at the source and risk to human health and the environment.

- *Green Polymer* Chemistry is an extension of green chemistry to polymer science and engineering



Paul Anastas

John Warner

"…the utilization of a set of principles that reduces or eliminates the use or generation of hazardous substances in the design, manufacture and application of chemical products."

12 Green Chemistry and Green Engineering Principles

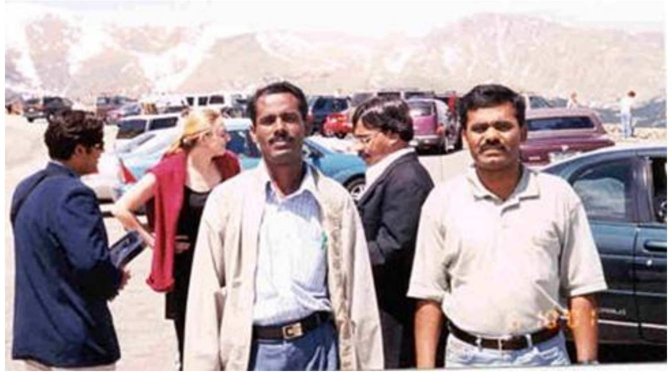
12 Green Chemistry Principles Key words: Productively

1.	P	-	Prevent wastes
2.	R	-	Renewable materials
3.	O	-	Omit derivatization steps
4.	D	-	Degradable chemical products
5.	U	-	Use safe synthetic methods
6.	C	-	Catalytic reagents
7.	T	-	Temperature, Pressure ambient
8.	I	-	In-process monitoring
9.	V	-	Very few auxiliary substances
10.	E	-	E-factor, maximize feed in product
11.	L	-	Low toxicity of chemical products
12.	Y	-	Yes it's safe

12 Green Engineering Principles Key words: Improvements

1.	I	-	Inherently non-hazardous and safe
2.	M	-	Minimize material diversity
3.	P	-	Prevention instead of treatment
4.	R	-	Renewable material and energy inputs
5.	O	-	Output-led design
6.	V	-	Very simple
7.	E	-	Efficient use of mass, energy, space & time
8.	M	-	Meet the need
9.	E	-	Easy to separate by design
10.	N	-	Networks for exchange of local mass & energy
11.	T	-	Test the life cycle of the design
12.	S	-	Sustainability throughout product life cycle

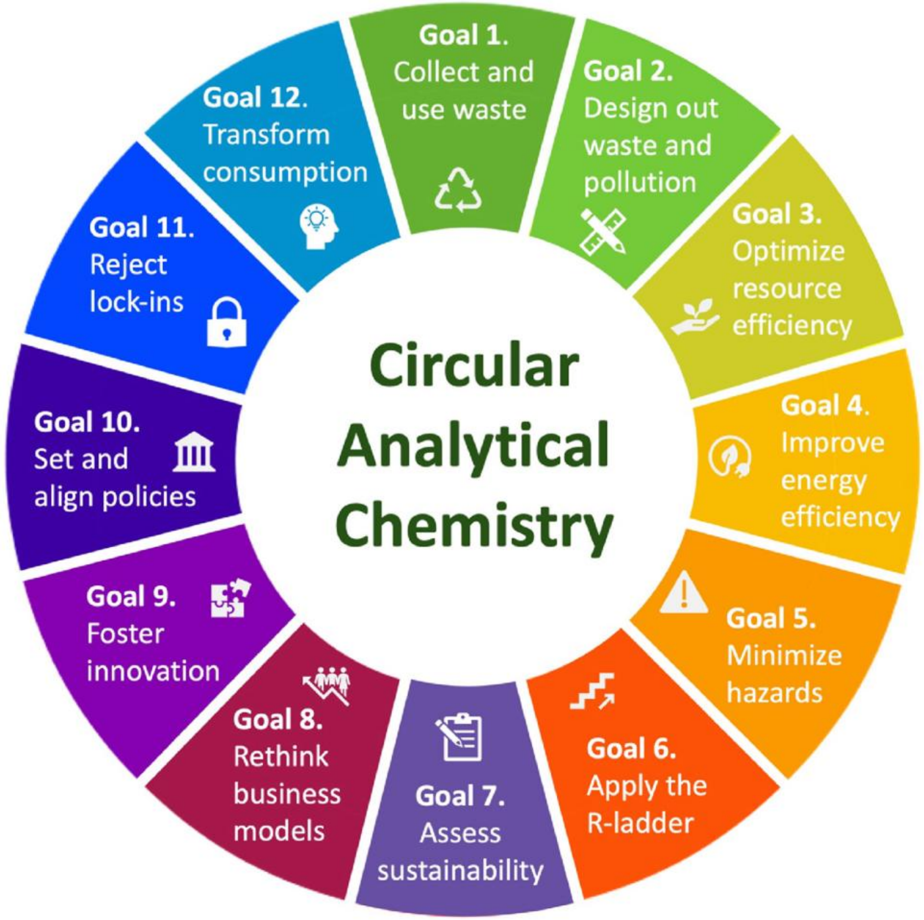
IUPAC CHEMRAWN XIV Conference and **Green Chemistry** Workshop, **University of Colorado**, Boulder, US (**June 6-14, 2001**) | With **Prof John Warner, Dr. Mary Kirchhoff** and **Dr. Paul Anastas** (Father of Green Chemistry)

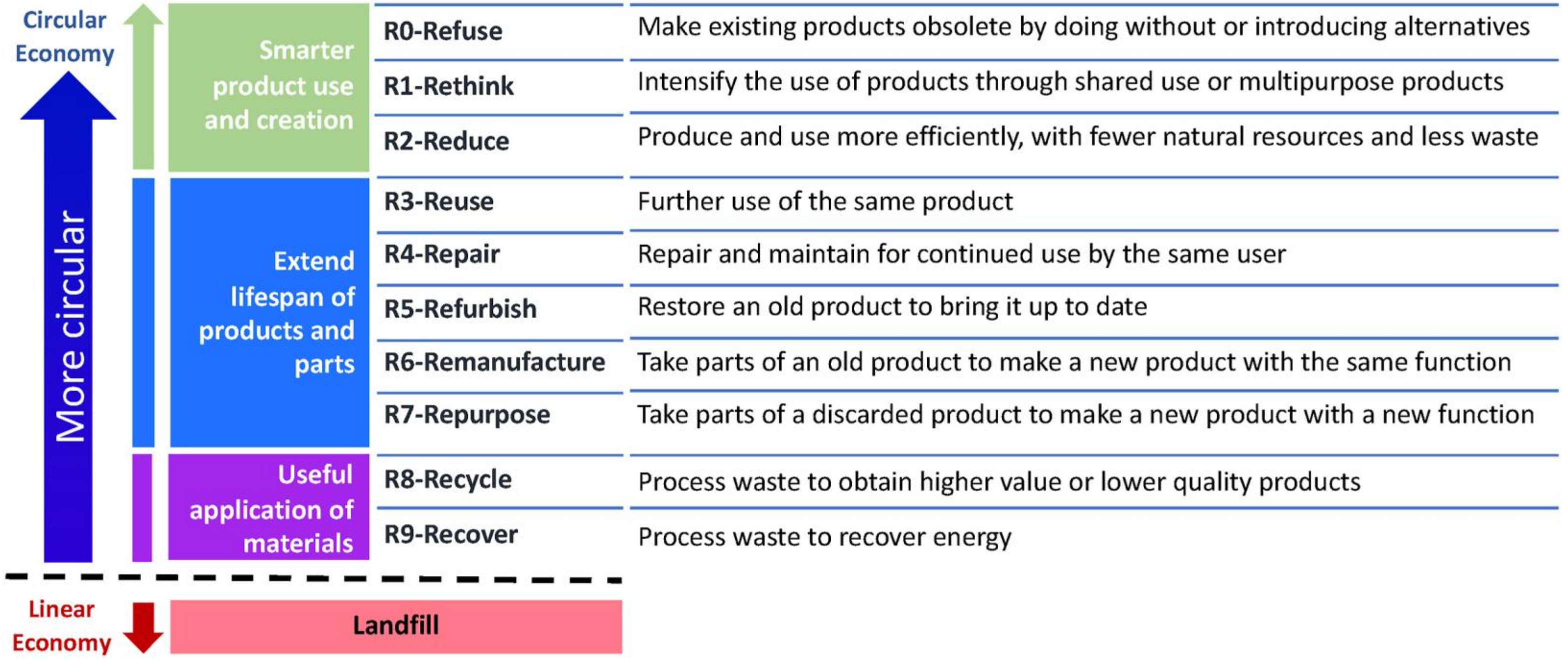


Indo-UK Workshop: Green Chemistry for Societal Needs: Healthcare, Pollution and Circular Economies (Dec 16-18, 2019), Hotel Maidens, New Delhi | Day 3 | Dec 18, 2019 | With **Dr. Mary Kirchhoff** ; **Prof. R. K. Sharma**

Circular Analytical Chemistry

The Twelve Goals of Circular Analytical Chemistry (CAC)

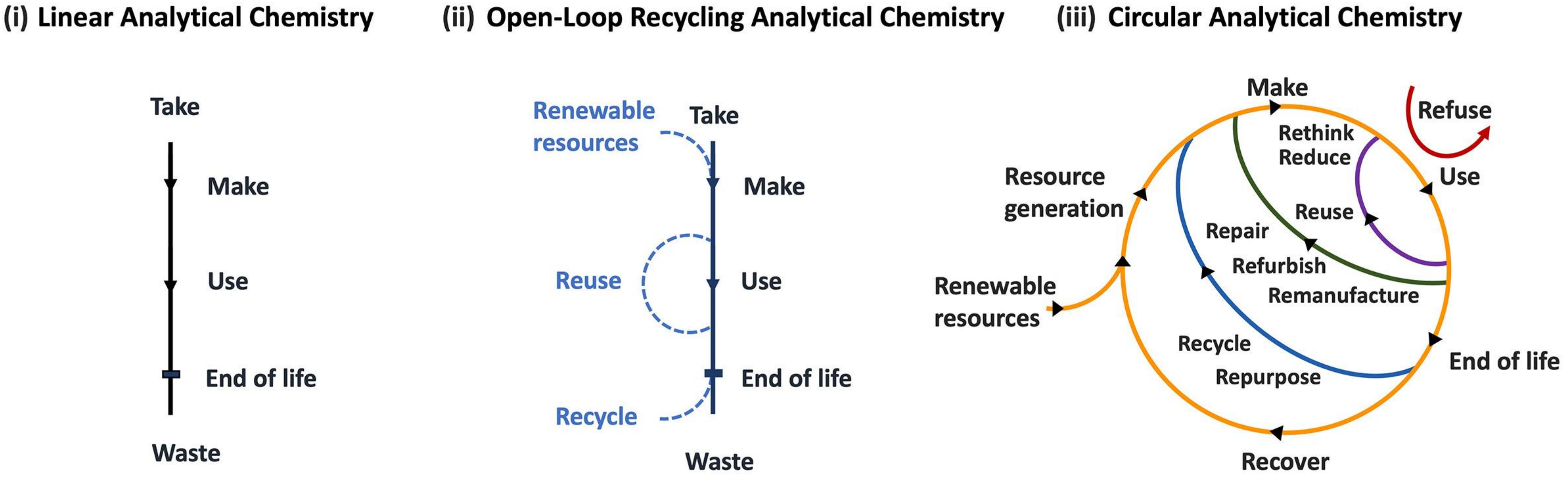




Trends in Analytical Chemistry **2024**, *175*, 117686
https://doi.org/10.1016/j.trac.2024.117686

Circular Analytical Chemistry

The Twelve Principles of Circular Analytical Chemistry (CAC)



Trends in Analytical Chemistry **2024**, *175*, 117686
https://doi.org/10.1016/j.trac.2024.117686

Circular Analytical Chemistry

The Twelve Principles of Green Analytical Chemistry (GAC)

GAC 1. **Direct analytical techniques** should be applied to avoid sample treatment.

GAC 2. Minimal sample size and minimal number of samples are goals.

GAC 3. In situ measurements should be performed.

GAC 4. Integration of analytical processes and operations saves energy and reduces the use of reagents.

GAC 5. Automated and miniaturized methods should be selected.

GAC 6. Derivatization should be avoided.

GAC 7. Generation of a large volume of **analytical waste** should be avoided and proper management of analytical waste should be provided.

GAC 8. **Multi-analyte** or multi-parameter methods are preferred versus methods using one analyte at a time.

GAC 9. The use of **energy** should be minimized.

GAC 10. **Reagents** obtained from **renewable source** should be preferred.

GAC 11. **Toxic reagents** should be eliminated or replaced.

GAC 12. The safety of the operator should be increased.

Nature Chem **2019,** *11*, 190–195
https://doi.org/10.1038/s41557-019-0226-9

Circular Analytical Chemistry

The Ten Principles of Green Sample Preparation (GSP)

GSP 1. Favor *in situ* sample preparation.
GSP 2. Use safer solvents and reagents.
GSP 3. Target sustainable, reusable, and renewable materials.
GSP 4. Minimize waste.
GSP 5. Minimize sample, chemical and material amounts.
GSP 6. Maximize sample throughput.
GSP 7. Integrate steps and promote automation.
GSP 8. Minimize energy consumption.
GSP 9. Choose the greenest possible post-sample preparation configuration for analysis.
GSP 10. Ensure safe procedures for the operator.

Nature Chem **2019,** *11*, 190–195
https://doi.org/10.1038/s41557-019-0226-9

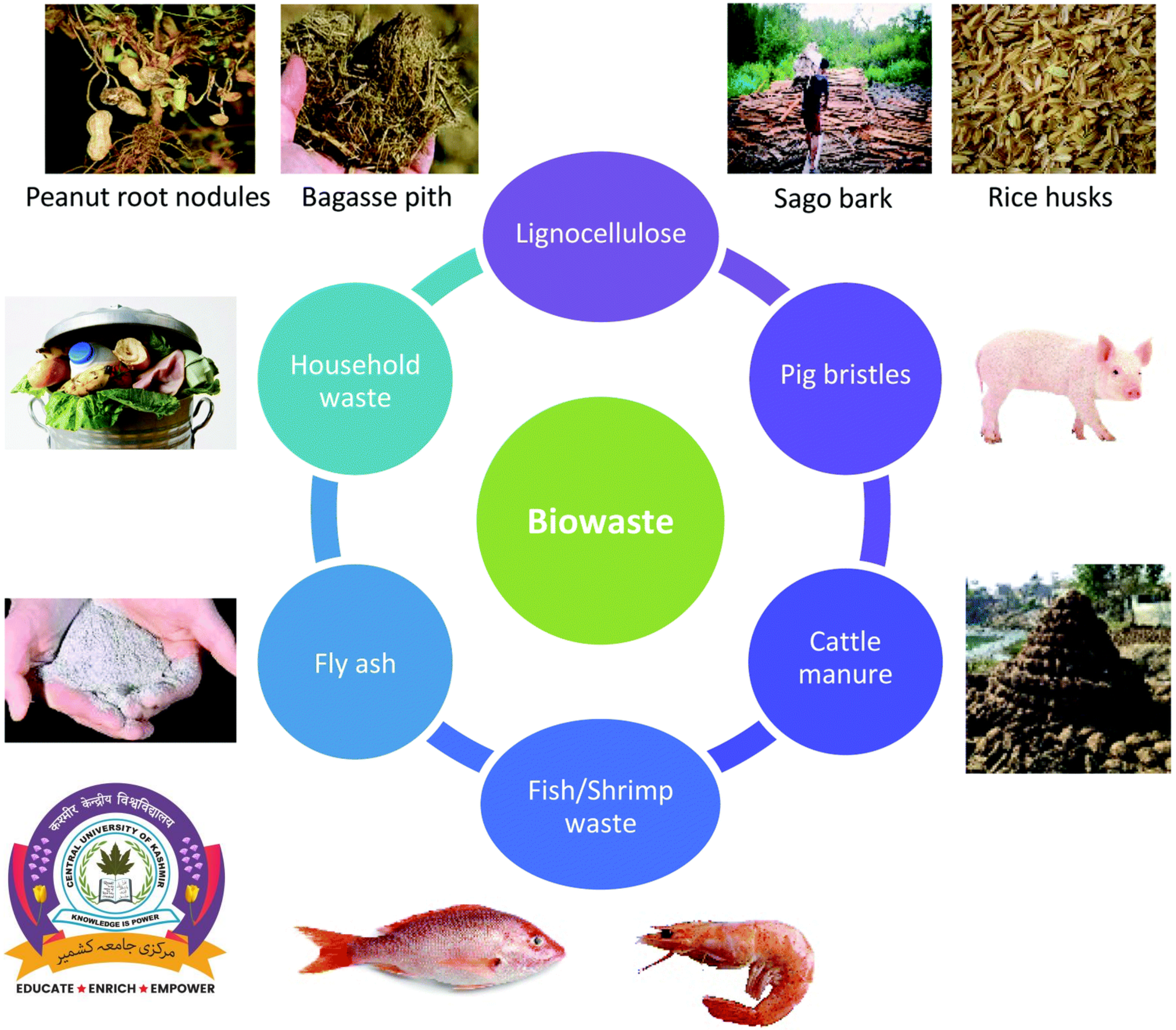
Biomass / Biowaste / Plastic Waste / Litters / Tyres Waste / E-waste

Litters

Tyres waste

E-waste

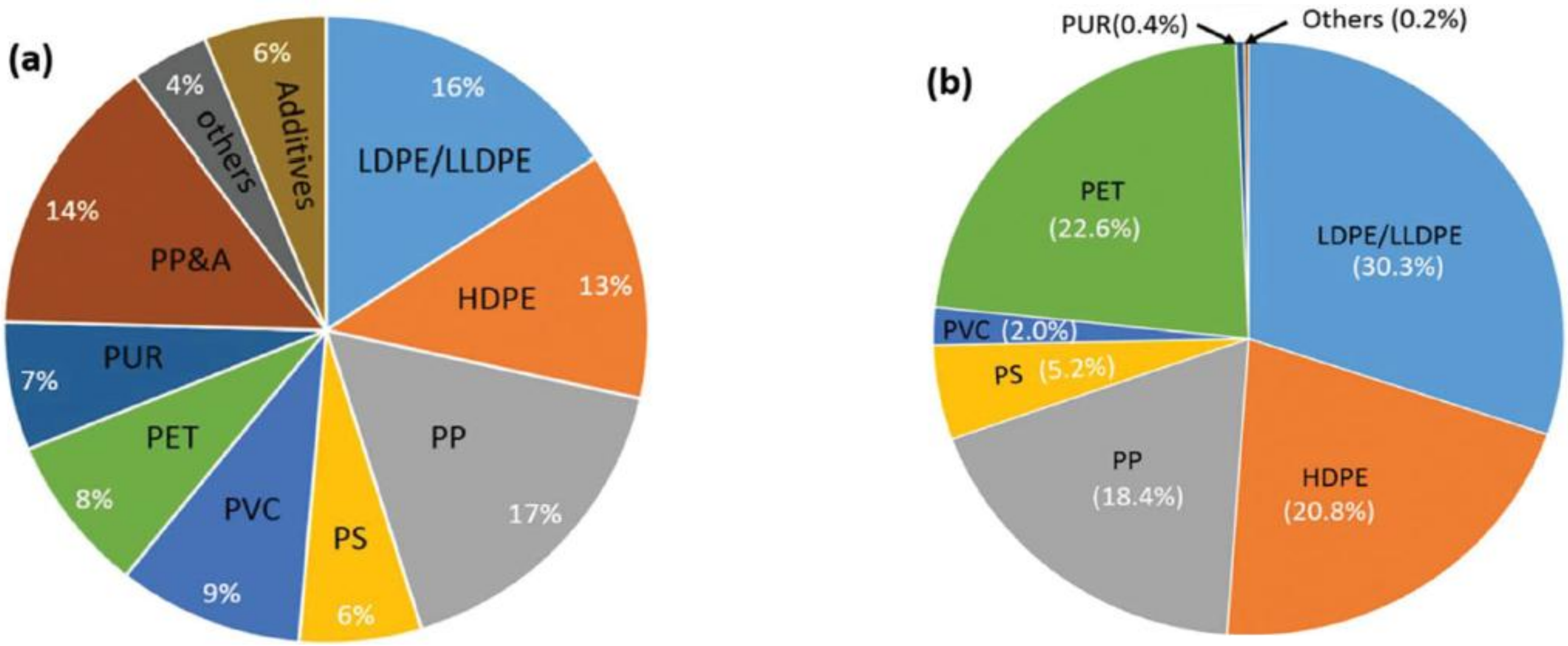
Most common and widely available biowaste feedstocks



Types of household waste

Chem. Soc. Rev., 2019,48, 4791-4822
DOI: 10.1039/C8CS00543E

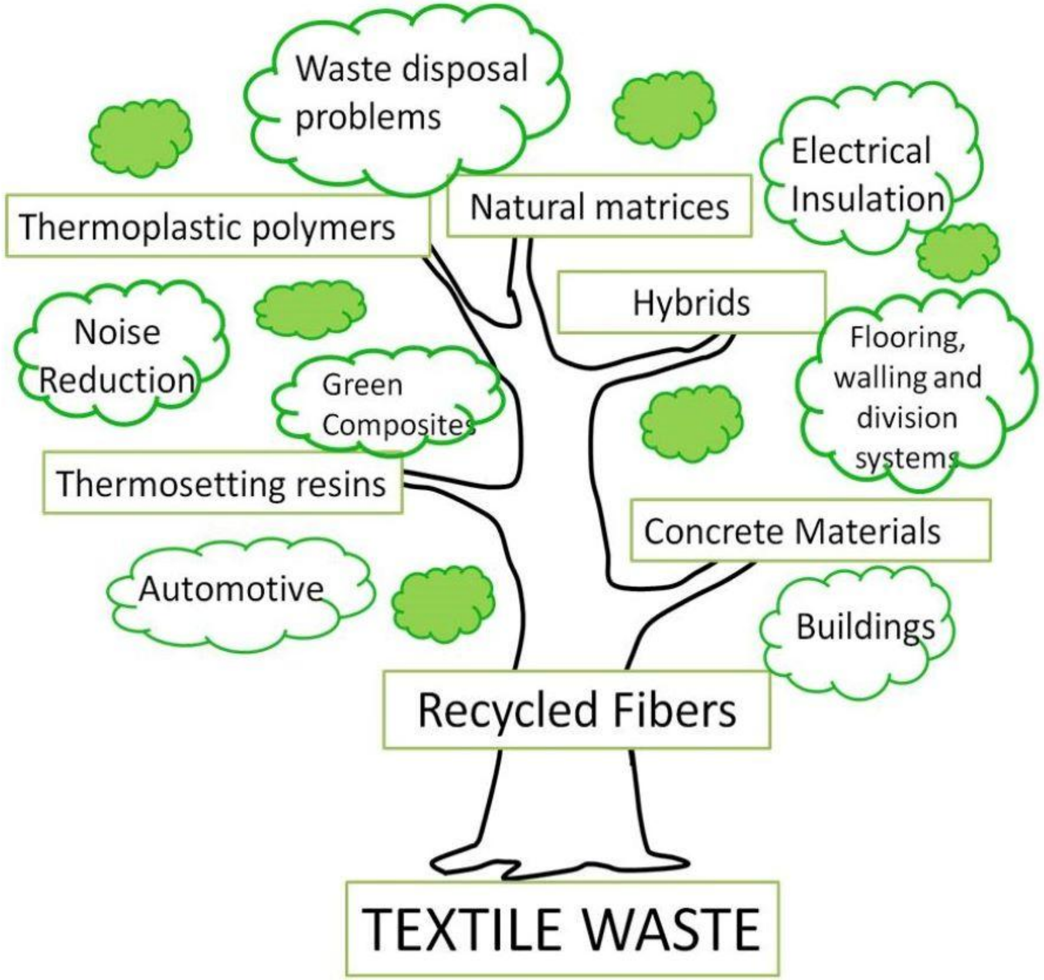
Plastic Waste



(a) Type of plastics produced worldwide (in percent); and (b) plastic use in the packaging industry in the world in 2015.

https://ifonlysingaporeans.blogspot.com/2018/08/singapore-uses-at-least-176-billion.html

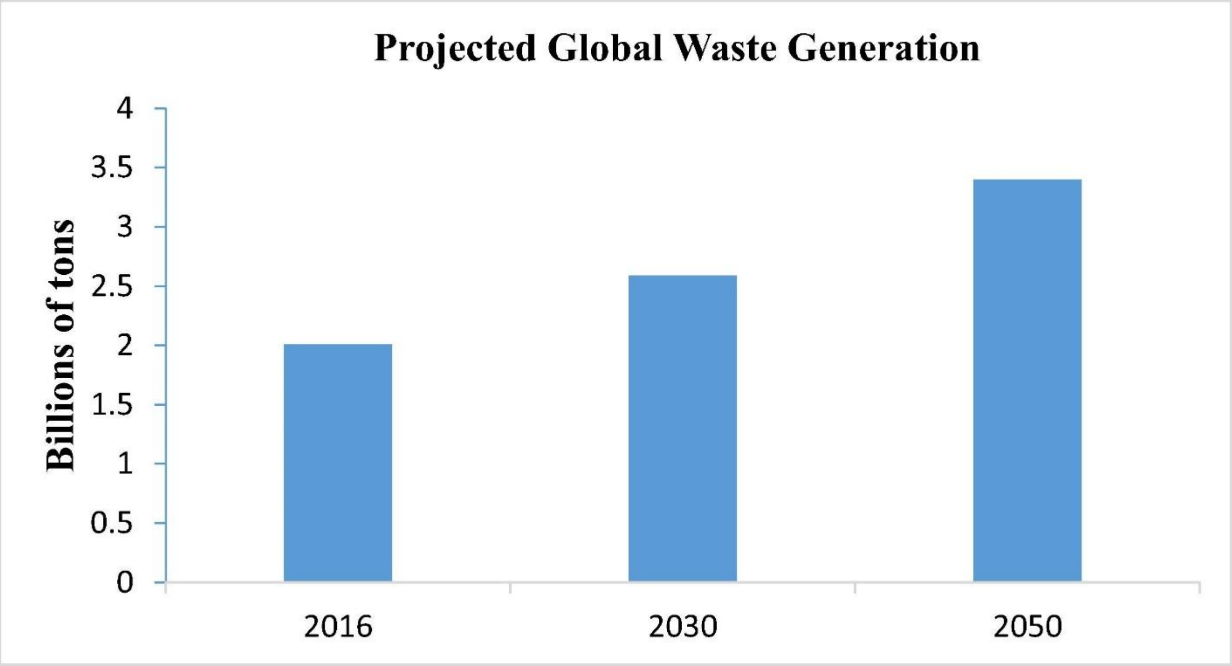
Textile Waste



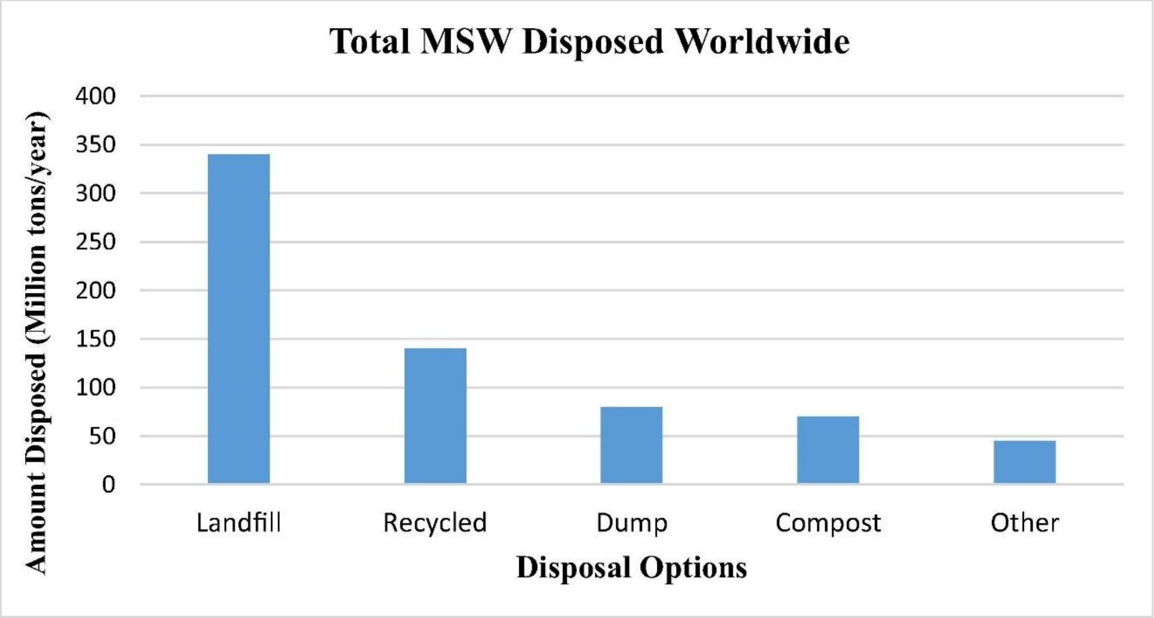
Polymers **2021**, *13*(1), 134; https://doi.org/10.3390/polym13010134

Examples of waste originated by textile world

Projected Global Waste



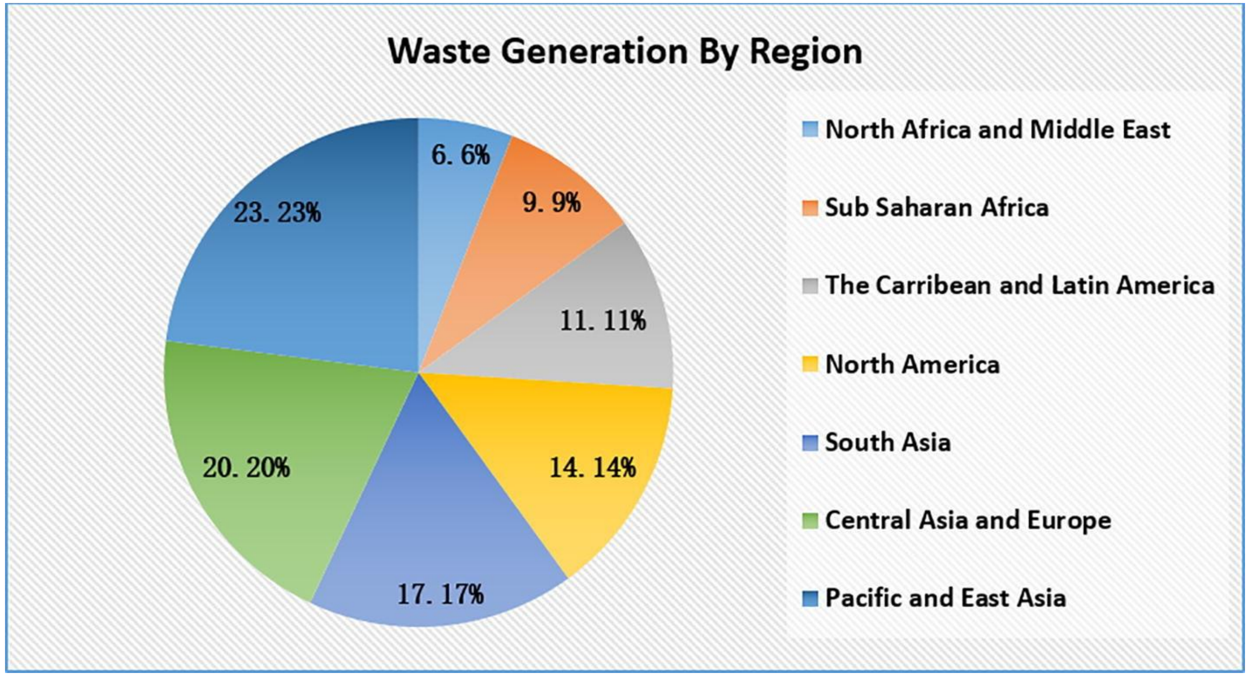
Amount of disposed waste in various segments of Municipal Waste Management (MSW)

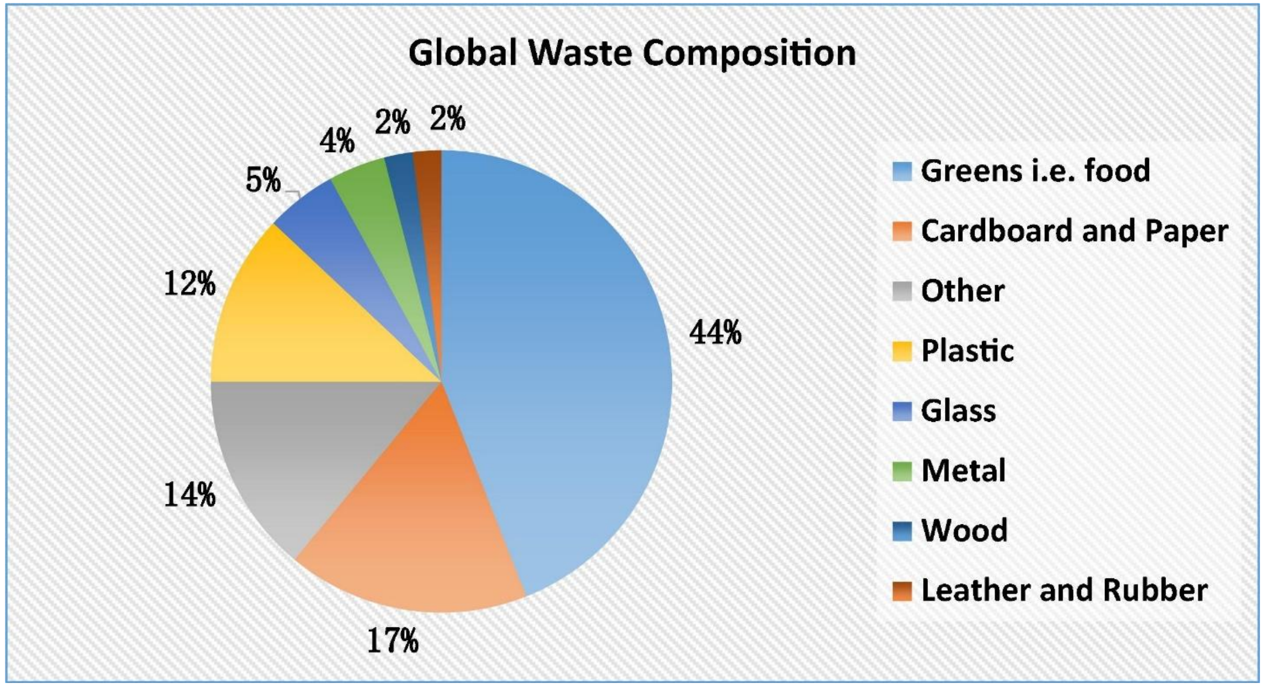


2021, 28, 3284–3293; https://doi.org/10.1016/j.sjbs.2021.02.072

Waste generation by region

Distribution for various waste composition globally





2021, 28, 3284–3293; https://doi.org/10.1016/j.sjbs.2021.02.072

Chemistry 4.0: Circular Economy and Sustainability

- All our surroundings are **chemistry**. Human progress without myriad **chemicals** is unimaginable. The chemical sector is a billion-dollar global business and supplies products and services that are profoundly useful to societal development.

- However, **fossil-fuel-based feedstocks**, energy-intensive production processes, **chemical waste** products, and numerous toxic pollutants amass to an emission-intensive and hazardous chemical sector.

- A **paradigm shift** is needed to leave behind this **"take-make-waste"** system (**Linear Economy**) to **Circular Economy** system (**6Rs**: **Rethink, Refuse, Reduce, Reuse, Repair and Recycle**).

- Achieving human progress and **green industrial production** *via* a **Circular Economy** that emulates the circularity of nature, an auto-balancing feature of our ecosphere, is the way forward to establish a sustainable and circular chemical sector.

Chemistry 4.0: Circular Economy and Sustainability

- **Chemistry 4.0: Circular Economy and Sustainability** begins the **fourth Industrial Revolution**, which will be shaped by digitalization and growth through Innovation.

- There has been a great deal of research and development into **Fourth Industrial Revolution** is known as **Industry 4.0** and its benefits, challenges, opportunities and promises to revolutionize the way we live and work.

- The **code 4.0** has been used to mark the disruptive change, which takes place in the manufacturing industry through the application of Artificial intelligence, internet of things, internet of systems, 5G technologies, bioinformatics, healthcare informatics, cloud computing, intelligent robots, mobile supercomputing and nanotechnology, creating the term **Industry 4.0**.

- Since then, the code 4.0 has been applied to many other fields, which are equally affected by the rapid changes in the world such as **Education 4.0**, Development 4.0, Healthcare 4.0, Work 4.0, workplace safety and health (WSH) strategy (WSH 4.0).

Chemistry 4.0: Circular Economy and Sustainability

A **new pedagogical paradigm shift** is required to change the **conventional** teaching, learning and curriculum framework to **circular** teaching methodology with blended mode of teaching and learning, students and teacher interactive session, critical thinking and analysis, practical approach, skill development and industrial oriented curriculum framework with **Sustainable Development Goals (SDGs)**.

Chemistry 4.0

Table 1 Development from Chemistry 3.0 to Chemistry 4.0 (source: own representation).

	Chemistry 3.0 Globalization & Specialization	Chemistry 4.0 Digitalization & Circular Economy
Drivers for transformation	Globalization, the European internal market, growing competiton from gas-based chemistry, the influence of financial markets on corporate strategies, commodification	Digital revolution, sustainability, climate protection, closing material cycles
Raw materials	Increasing use of renewable raw materials and natural gas	Intensive use of data, recycling of carbon-containing waste, H_2 from renewable energies in combination with CO_2 used to produce base chemicals
Technology	New synthesis and production processes through biotechnology and gene technology, enlargement of individual processes	Digitalization of manufacturing processes
Research	Close cooperation between basic research in universities and application-oriented research in companies	Decentralization of R&D in customer markets, utilization of Big Data, joint development with customers
Corporate structure	Internationalization of trade and on-site production abroad, specialization and growth in SMEs, consolidation through M&A, creation of chemical parks	More flexible cooperation as part of economic networks, digital business models and consolidation
Products	Expanding product range, specialty chemicals oriented to specific customer requirements, new drugs, replacement of traditional materials with chemical products	Expanding the spectrum of value creation: chemical sector becomes a supplier of extensive and sustainable solutions for customers and the environment
Environment, Health and Safety	Environmental protection integrated into production, increasing product safety through expanded review of material properties, responsible care	With chemistry (ecology, economy and social affairs), sustainability becomes a comprehensive model and future concept for the industry

Journal of Business Chemistry **2018**, *15 (1)*, 42-53

Reduce | Refuse | Reuse | Redesign | Recycle

- Every year, the world produces more than two billion tonnes of **municipal solid waste**. If all that waste was packed into standard shipping containers, it would wrap around the globe 25 times.

- Everyone can play a part in achieving a more sustainable future.
  - Reduce waste.
  - Refuse packaging, shopping bags, or other products or services you don't need.
  - Reuse and redesign items instead of replacing them.
  - Recycle.

https://www.un.org/en/observances/zero-waste-day

Reduce | Refuse | Reuse | Redesign | Recycle

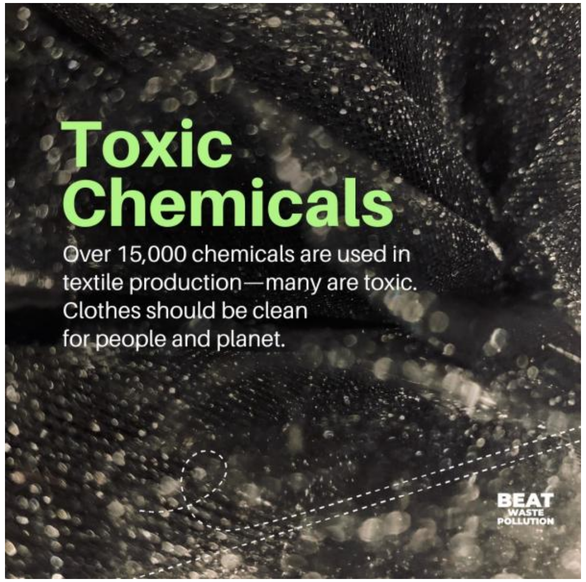
- A **circular fashion industry** could unlock $700 billion by 2030.

- That means **reducing** overproduction, **designing** durable and **reusabl**e products, and keeping **textiles** out of landfills through **reuse** and **recycling**.

https://www.unep.org/events/un-day/international-day-zero-waste-2025

International Day of Zero Waste 2025 | March 30

Theme 2025: **Towards zero waste in fashion and textiles**



- The fashion industry is one of the world's most polluting—and wasteful. But it doesn't have to be.
- From **circular design to better recycling**, smarter marketing to consumer choice, everyone has a role to play.
- Explore 5 ways we can transform the way we produce, wear, and value our clothes—and start reshaping fashion to **Beat Waste Pollution**: **https://bit.ly/3DY7v7D**

With onion peels and sage dyes, designers hope to make fashion more sustainable

- From 3D-printing plant-based textiles to dyeing clothes with sage, walnut or onion peels, young designers are rethinking fashion from the ground up.

- With onion peels and sage dyes, designers hope to make fashion more sustainable
  https://bit.ly/43v80AE

Designer Batoul Al-Rashdan, a trained engineer, creates plant-based materials, which she turns into clothes and accessories. Courtesy of Batoul Al-Rashdan

Sustainability, Sustainable Development, Sustainable Polymers, Green Polymers

- The word ***sustainability*** derives from the French verb ***soutenir*** which means to **hold up or support**.

- The forestry industry, and later ecologists, used the concept of **sustainability** to ensure that we do not exceed nature's ability to regenerate itself by setting limits on resource extraction.

- The related concept of **sustainable development** was framed in a **1987 United Nations document** called the **Brundtland Report**, which mainstreamed the idea of "**meet[ing] the needs of the present without compromising the ability of future generations to meet their own needs**".

- Since that time, approaches to **sustainability** have been categorized as either **weak** or **strong**. The **strong sustainability** approach asserts that future generations should inherit an equal stock of environmental assets. **Weak sustainability** posits that future generations should inherit a stock of wealth, composed of both human-made and environmental assets, with equivalent value to the stock inherited by prior generations.

- In the polymer field, early uses of the word ***sustainable*** **described actions** (e.g., sustainable **polymer recycling** or **sustainable polymer processing**). Later uses include labeling the polymer itself as *sustainable*.

- The **International Union of Pure and Applied Chemistry subcommittee on polymer terminology** has **not (yet)** defined *sustainable polymer*; the closest match is ***green polymer***, which refers to a **polymer** that conforms to the concept of **green chemistry**. As a consequence, the definition of ***sustainable polymer*** **has remained ambiguous and open to interpretation**.

ACS Macro Lett. 2021, 10, 1, 41–53
DOI: 10.1021/acsmacrolett.0c00789

Sustainable Polymers / Green Polymers / Green Materials

Green Materials

Green Polymers		Green Monomers
Biopolymers	Biomaterials	Biomonomers
Biobased Polymers		Biobased Monomer
Biodegradable Polymers	Smart Materials	Biodegradable Monomers
Renewable Polymers		Renewable Monomers
Sustainable Polymers	Flexible Materials	Sustainable Monomers
Smart Polymers	Recycled Polymers / Materials	Recycled Monomer

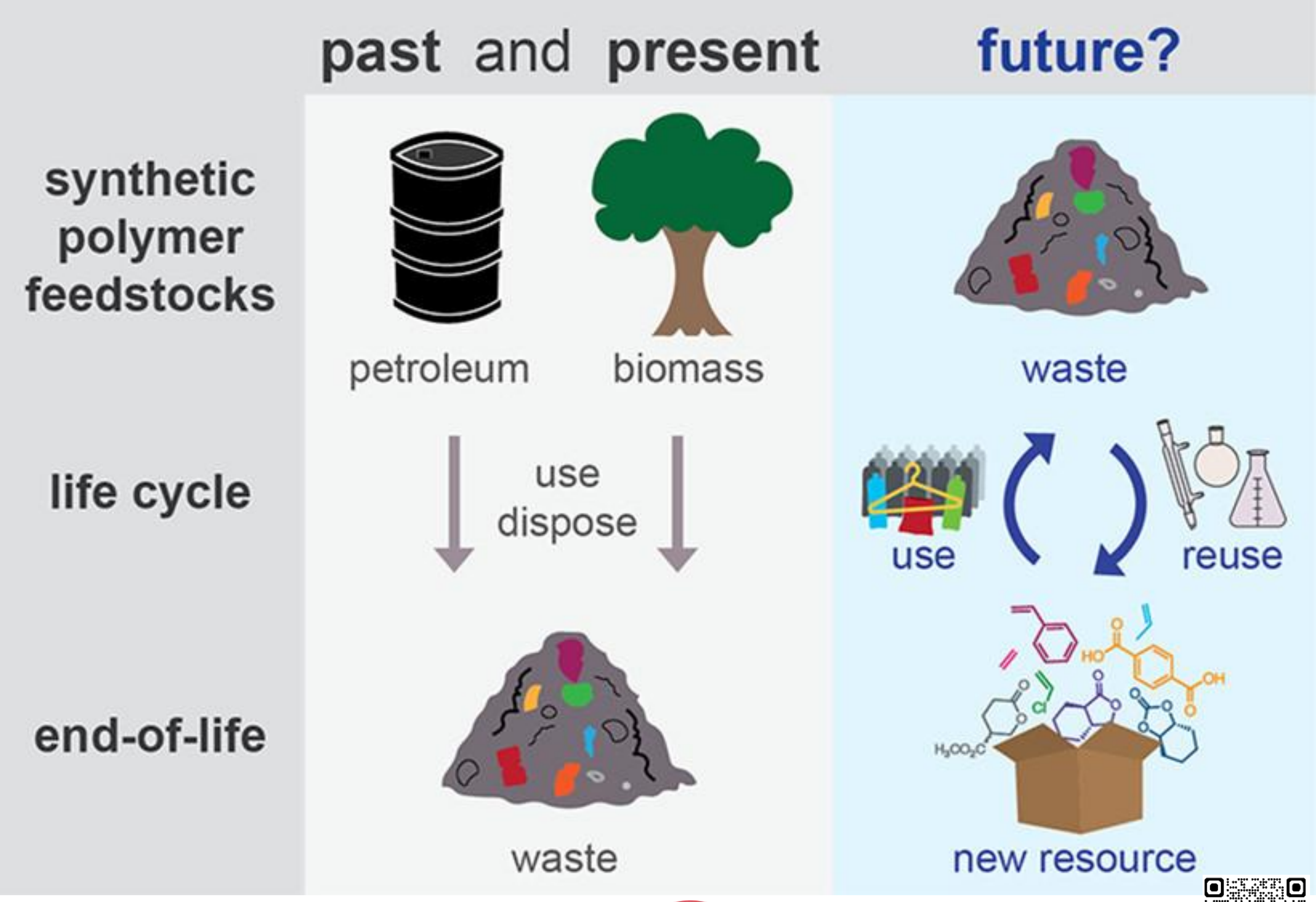
Sustainable Polymers / Green Polymers / Green Materials

- With 6.3 billion metric tons of plastic waste now contaminating our land, water, and air, we are facing an environmental and public health crisis.

- Synthetic polymer chemists can help create a more sustainable future, but are we on the right path to do so?

- Moving forward, we suggest an increased emphasis on chemical recycling, which sees value in plastic waste and promotes a closed-loop plastic economy.

- To help keep us on the path to sustainability, the synthetic polymer community should routinely seek the systems perspective offered by Life Cycle Assessment (LCA).



ACS Macro Lett. 2021, 10, 1, 41–53
DOI: 10.1021/acsmacrolett.0c00789

Valuable Products made from wastes

Wheat Straw Baby Kids Dinner Plate Dinnerware

Wheat Straw Plastic Food Storage Seal Pot

Biodegradable Bags

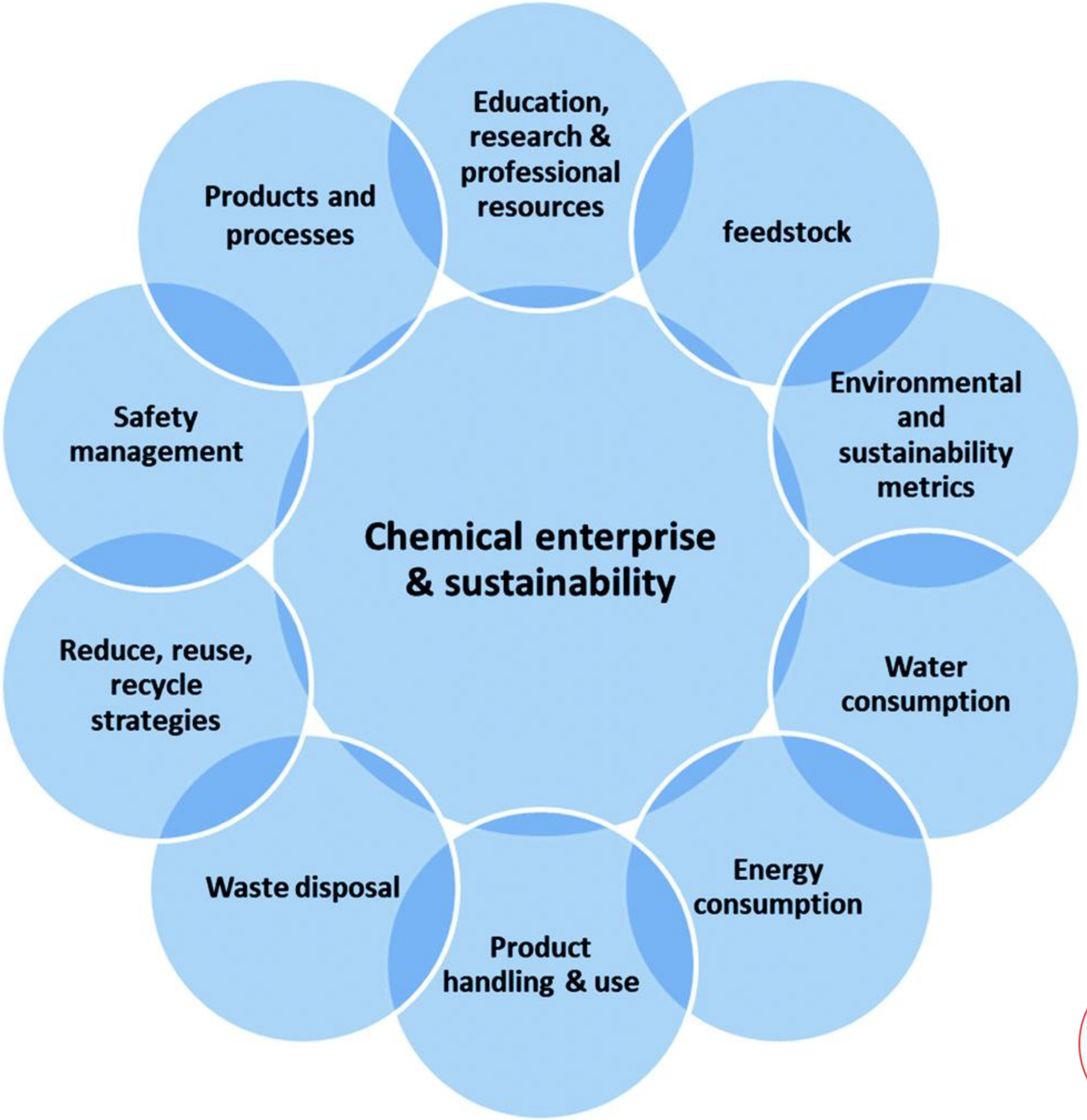
Furniture made from waste tyres

FROM NATURE FOR NATURE
YSB FOUNDATION

Structure of chemical enterprise towards sustainability

Sustainable Development

Green Chemistry and Engineering



Green Chem., 2021, 23, 1594; DOI: 10.1039/d0gc03313h

Sustainable Methodology

Circular Economy

Life Cycle Assessment

Green Chemistry and Engineering

Biomass Conversion

Green Technology and Awarness

Smart Materials

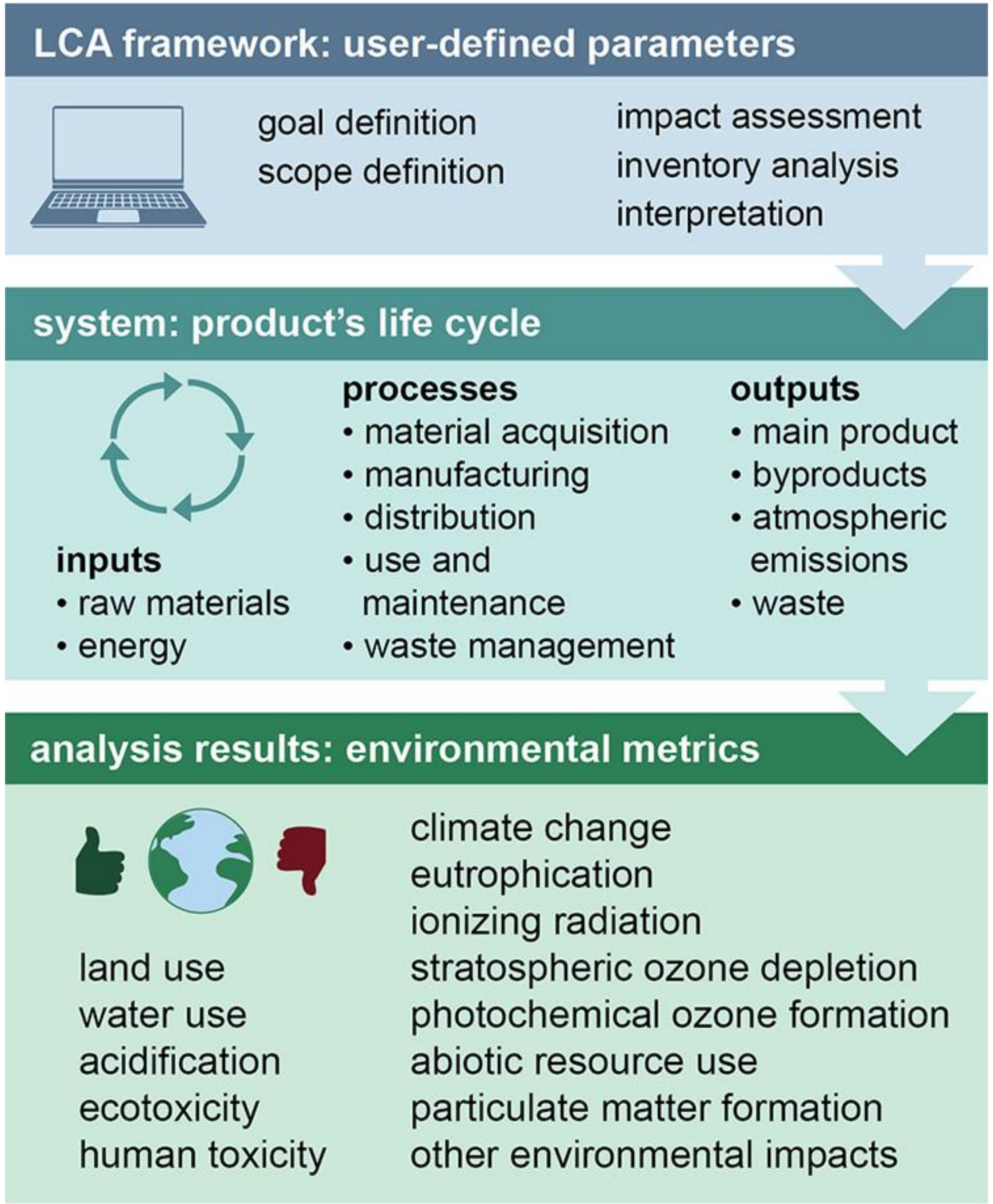
Life Cycle Assessment (LCA)

- ❖ **Life cycle assessment (LCA)** is a methodology for **analyzing the entire life cycle of a system or product**—resource obtainment, production, use, and disposal—to quantify environmental impact (Figure).

- ❖ **LCAs yield best estimates** by (1) mapping all emissions and resource uses and, if possible, their geographical locations and (2) using mathematical cause/effect models to calculate potential environmental impacts.

- ❖ These measurements are rooted in natural science and value judgments, which assign weights to different environmental problems, that are both consistent and transparent.

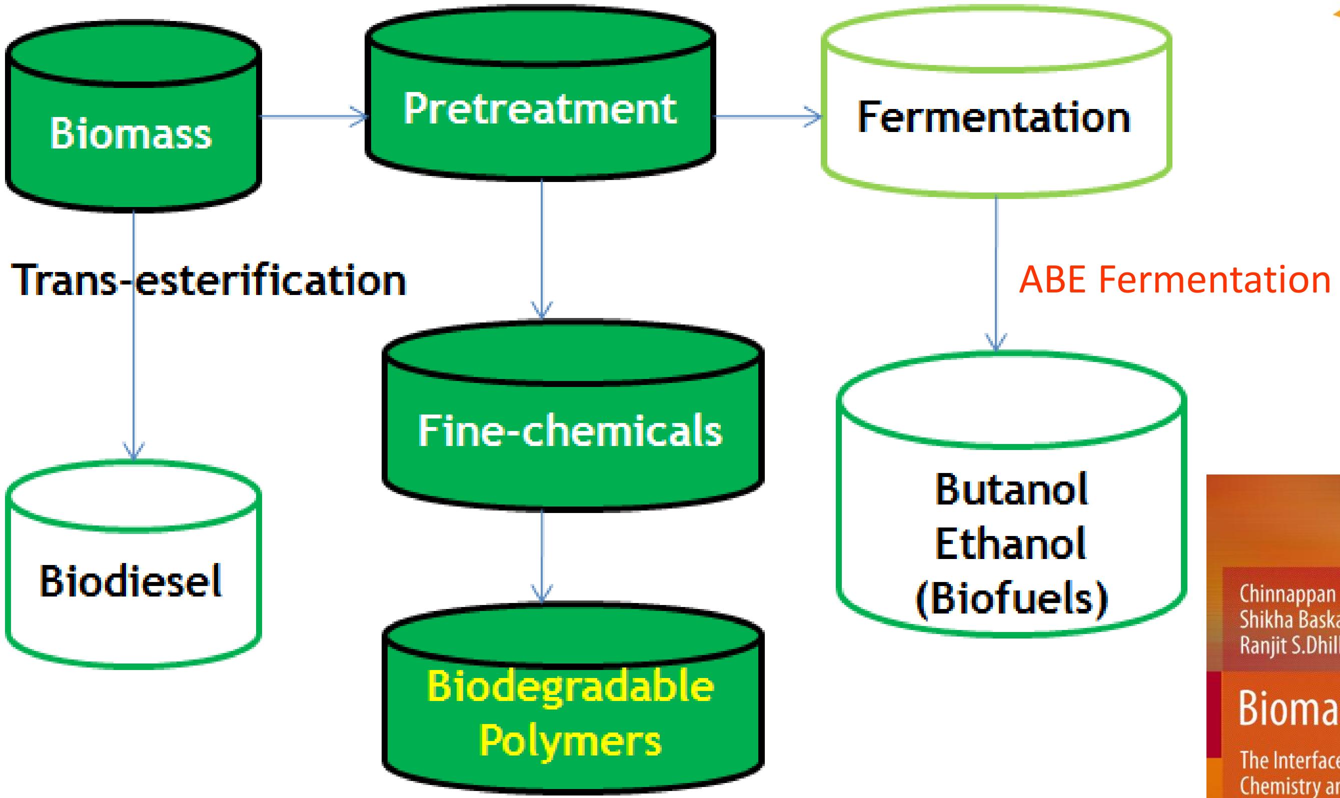
- ❖ LCA standards were developed by the ISO with the European Union creating more updated protocols meant to enable useful comparisons between different studies.

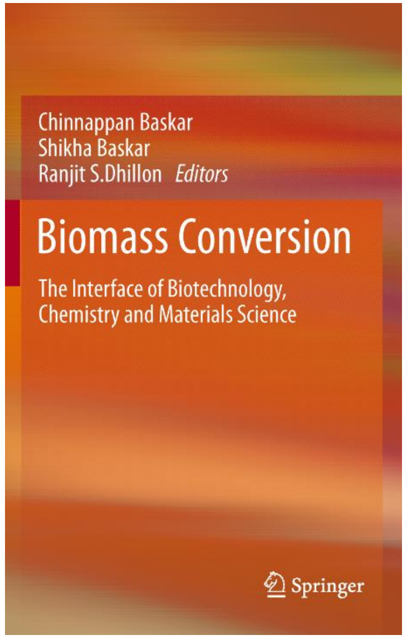


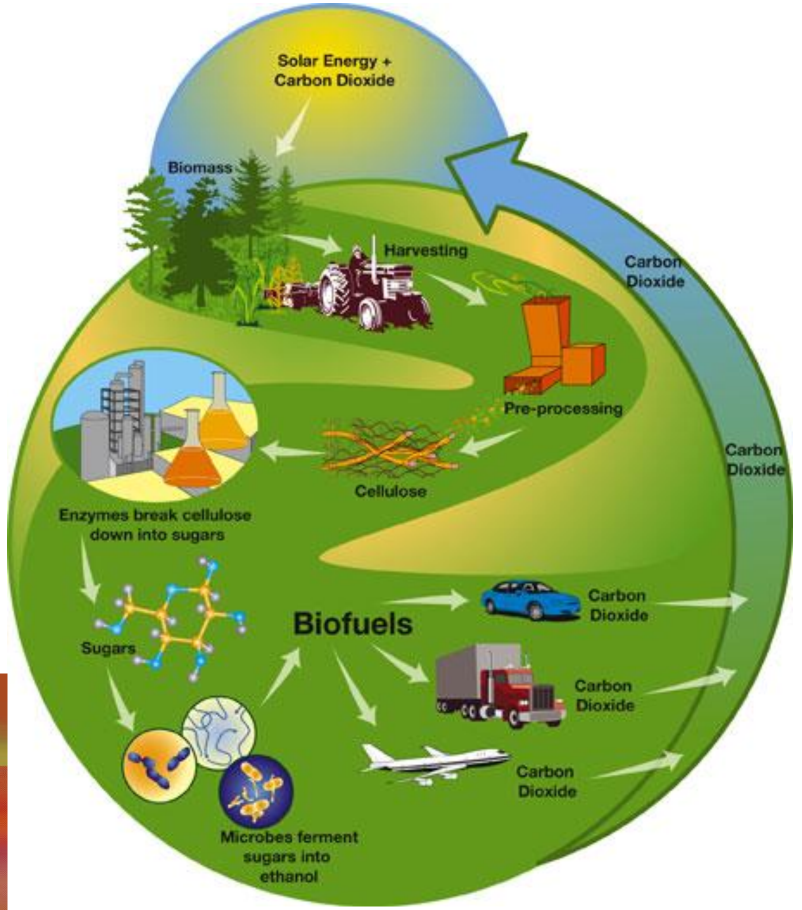
Components of a life cycle assessment and key outcomes

ACS Macro Lett. 2021, 10, 1, 41–53
DOI: 10.1021/acsmacrolett.0c00789

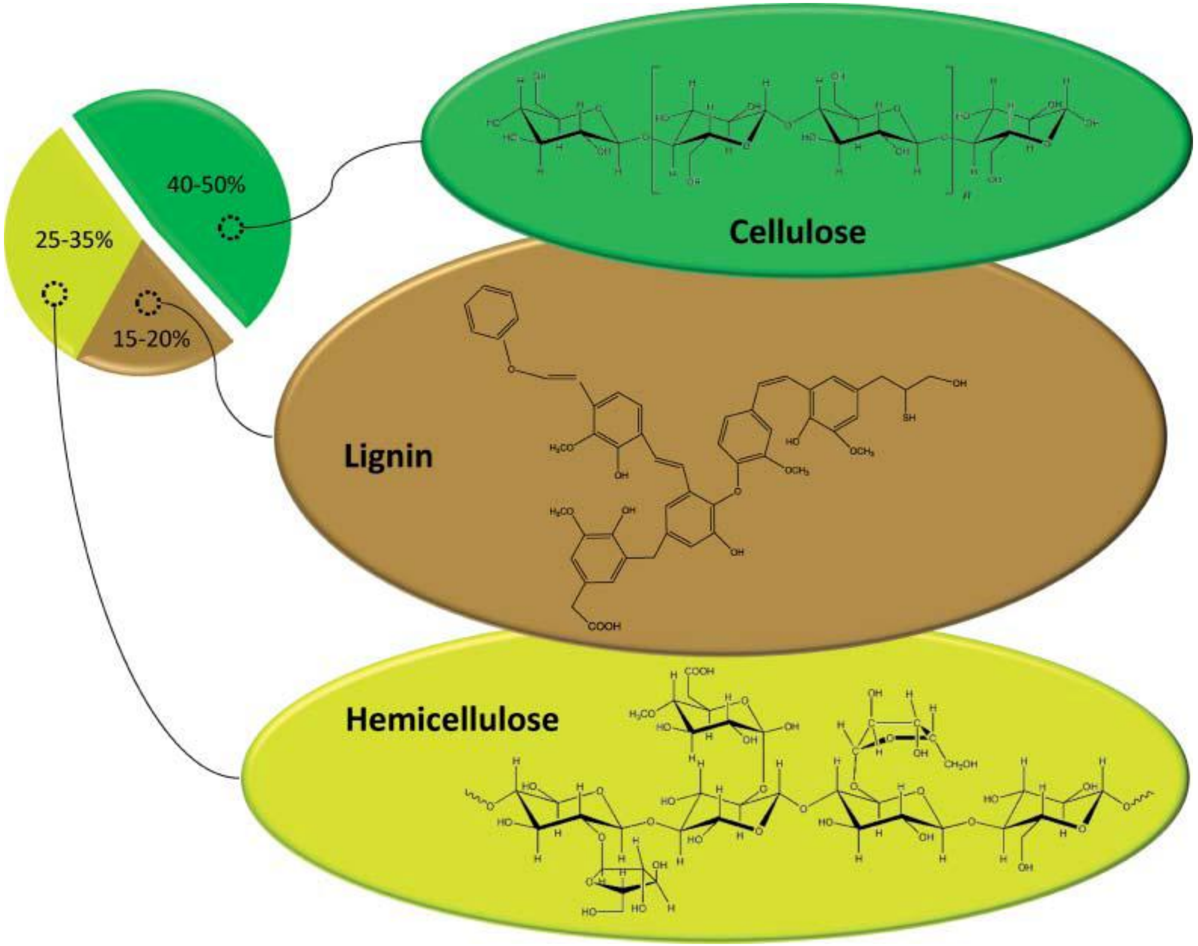
Biomass Conversion







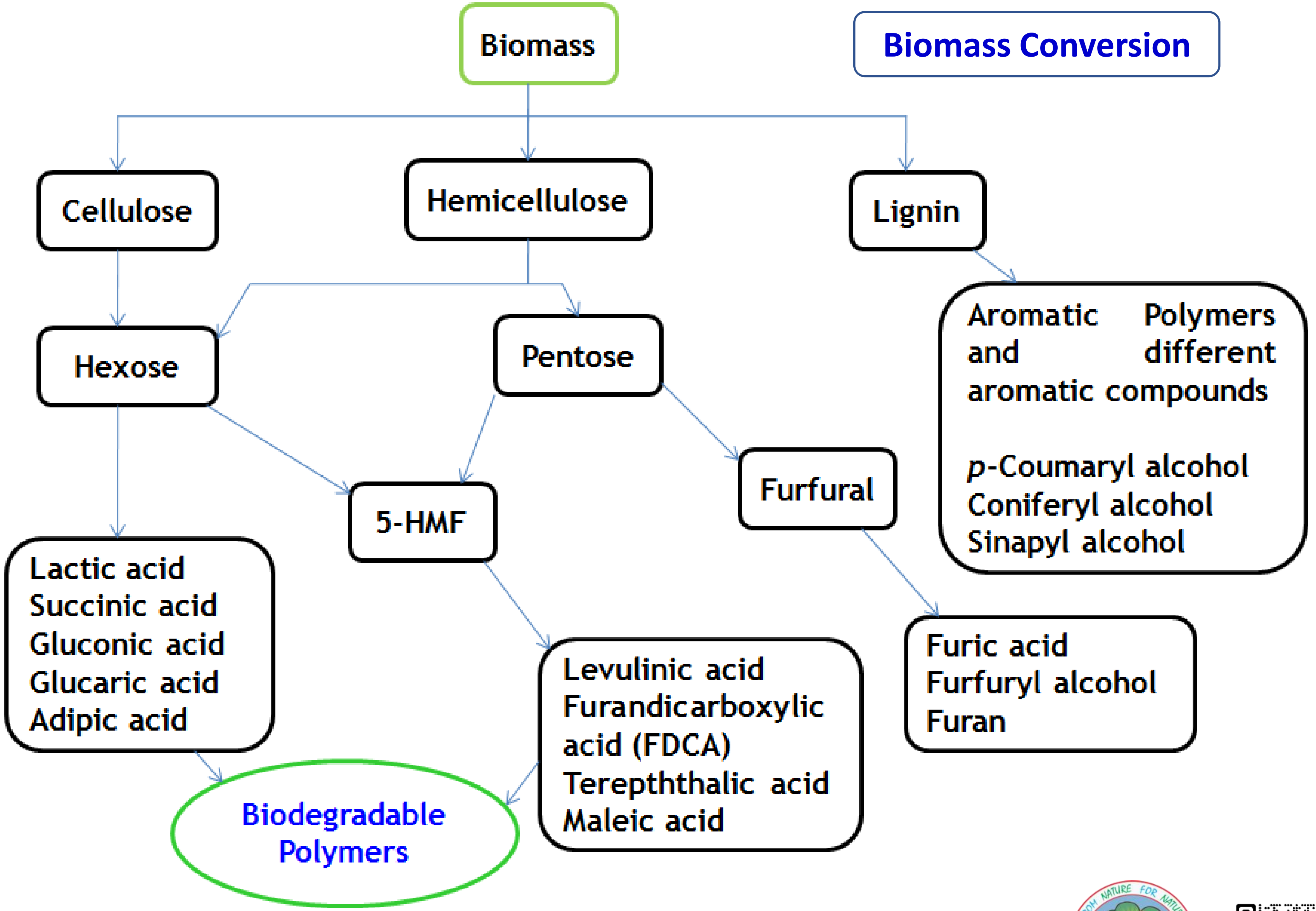
Chemical Structures of Biomass Feedstock



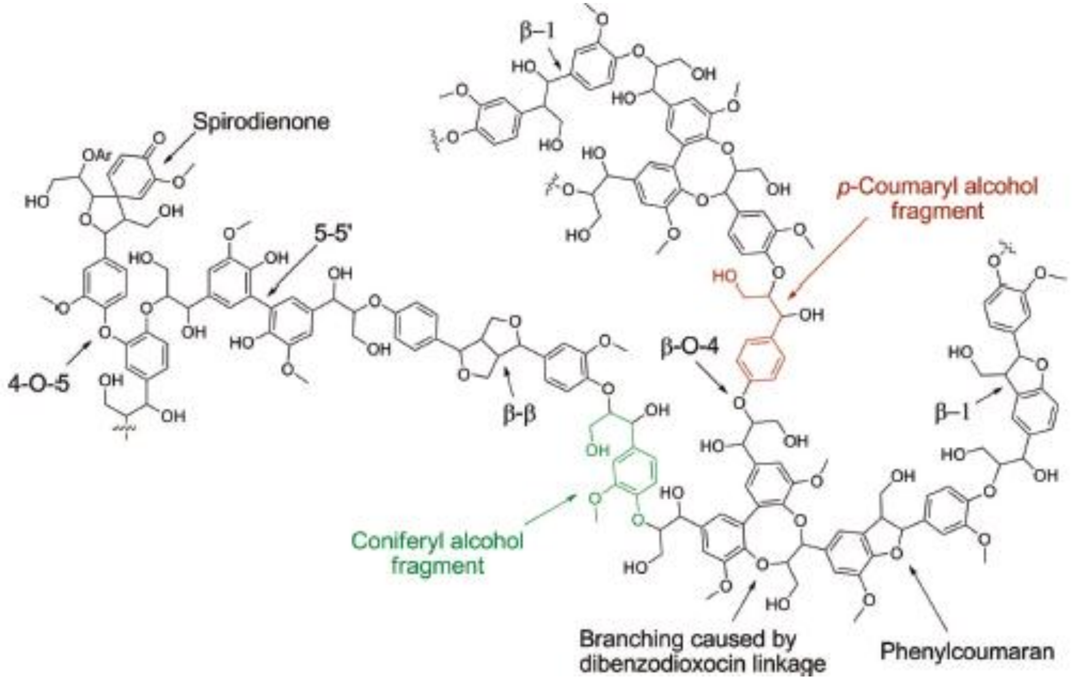
Lignocellulosic Biomass Composition

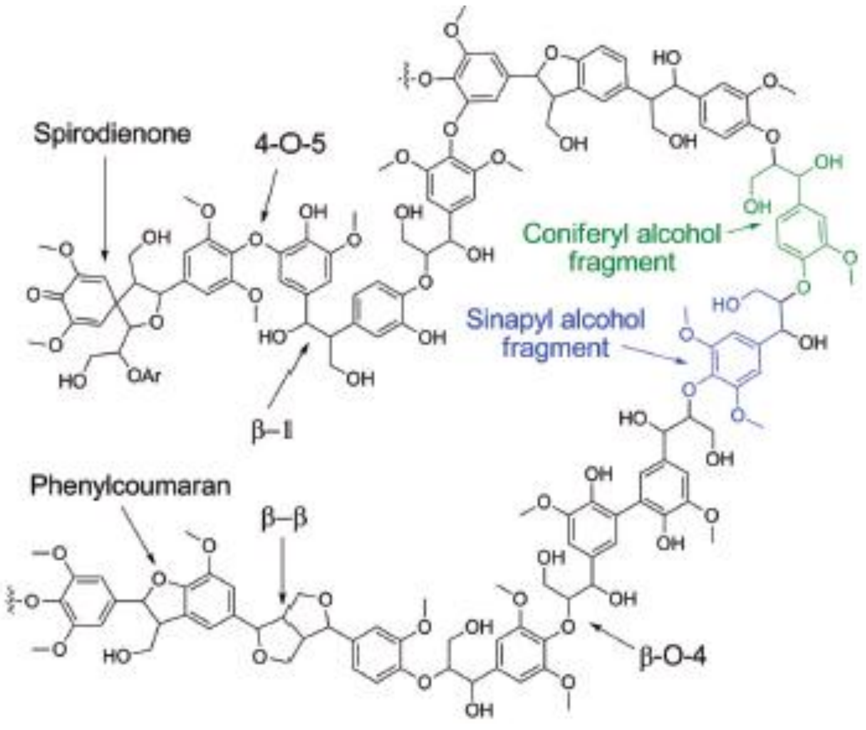
- The most abundant and renewable source of carbon on the planet
- Lignocellulosic biomass can be grouped into four main categories: **agricultural residues, dedicated energy crops, wood residues, municipal paper waste**
- **Lignocellulosic:** hemicellulose, cellulose, and lignin
- The isolation of biomass fractions typically proceeds through **pretreatment** followed by hydrolysis.
- The **pretreatment**: both physical (*e.g.*, milling, comminuting, steam) and chemical (*e.g.*, acid or base hydrolysis/ILs) methods

Biomass Conversion



Biomass Conversion (Lignin)

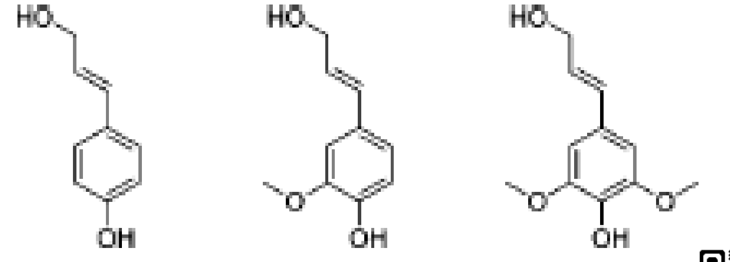




Schematic representation of a hardwood lignin structure

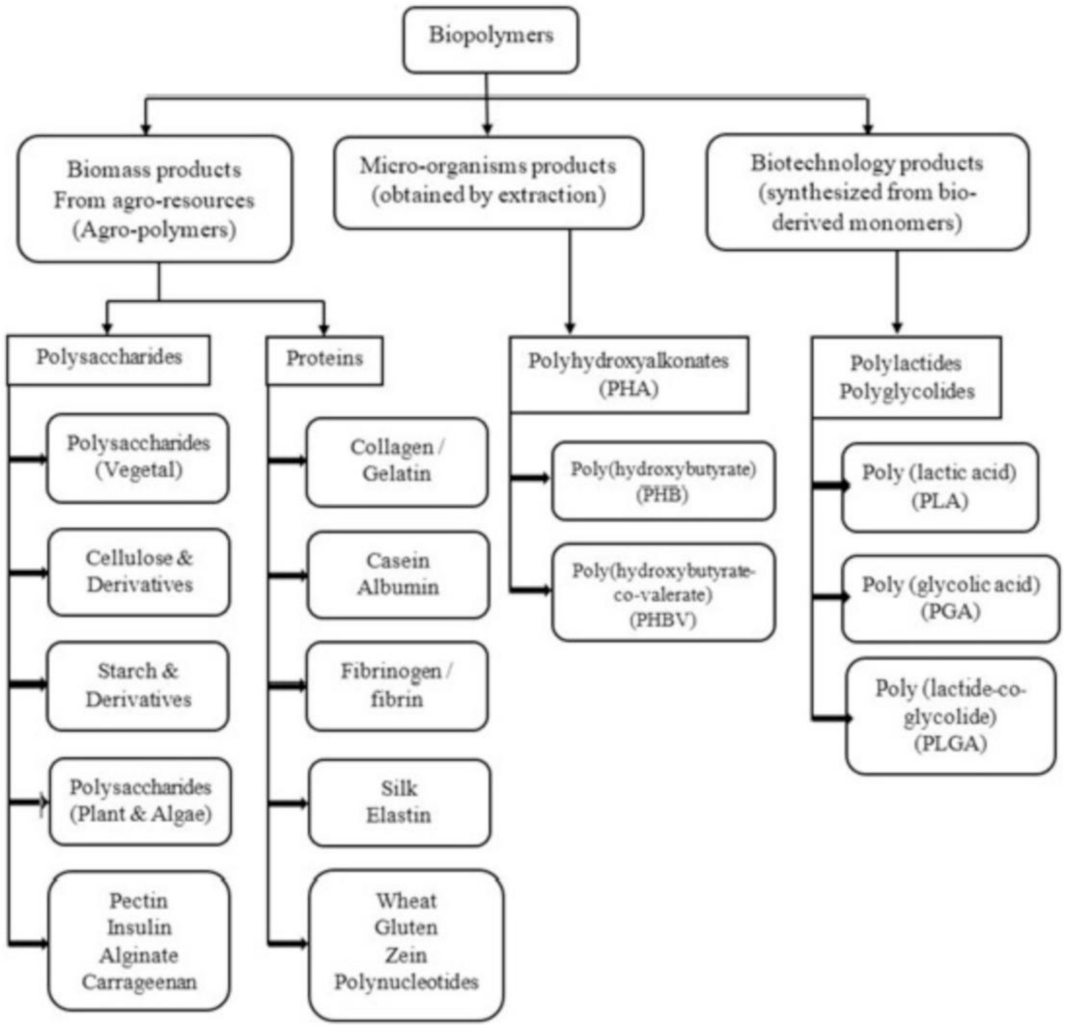
Schematic representation of a softwood lignin structure

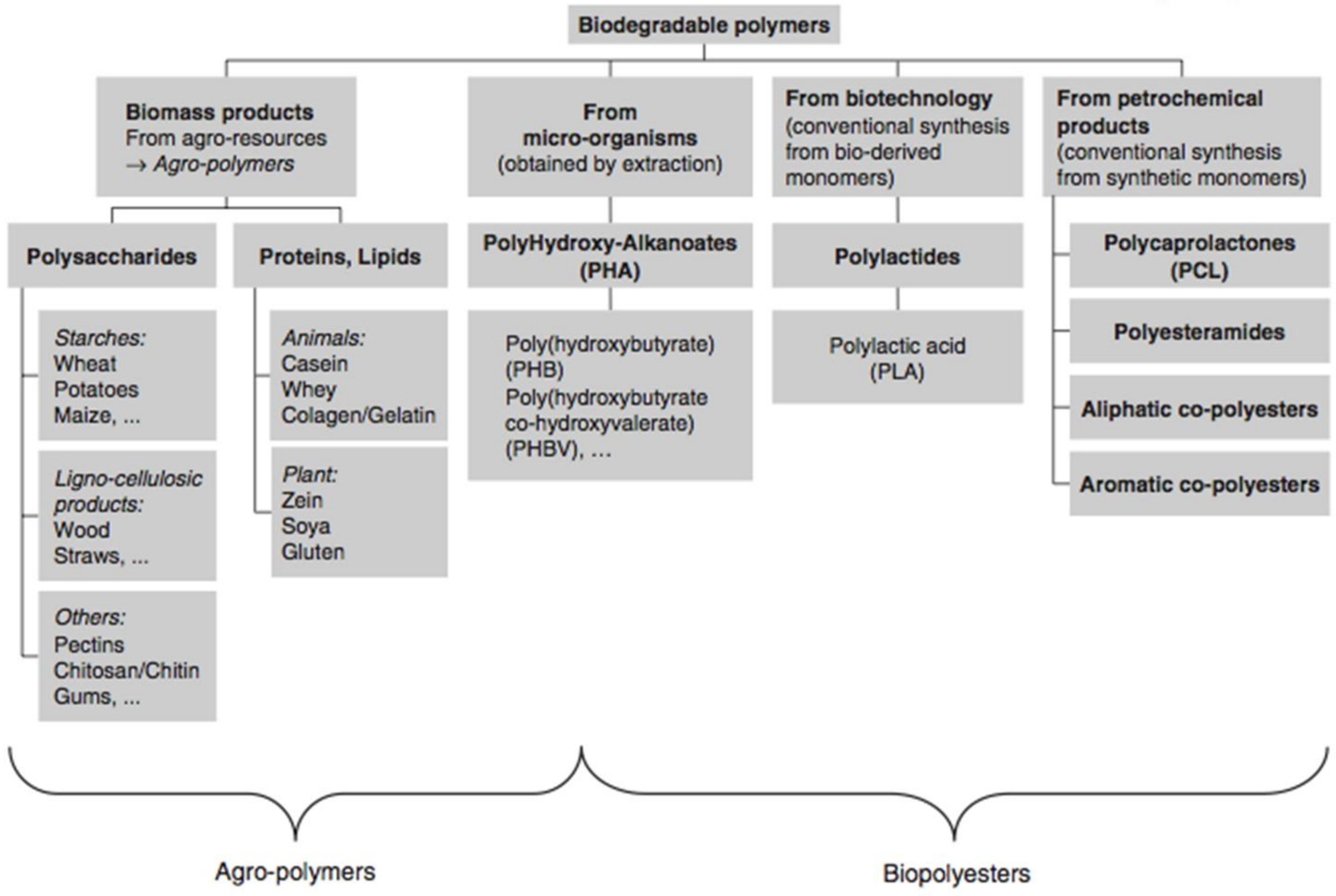
The three monolignols, the building blocks of lignin: **Green Monomers**



p-coumaryl alcohol coniferyl alcohol sinapyl alcohol

Classification of Biopolymers / Biodegradable Polymers





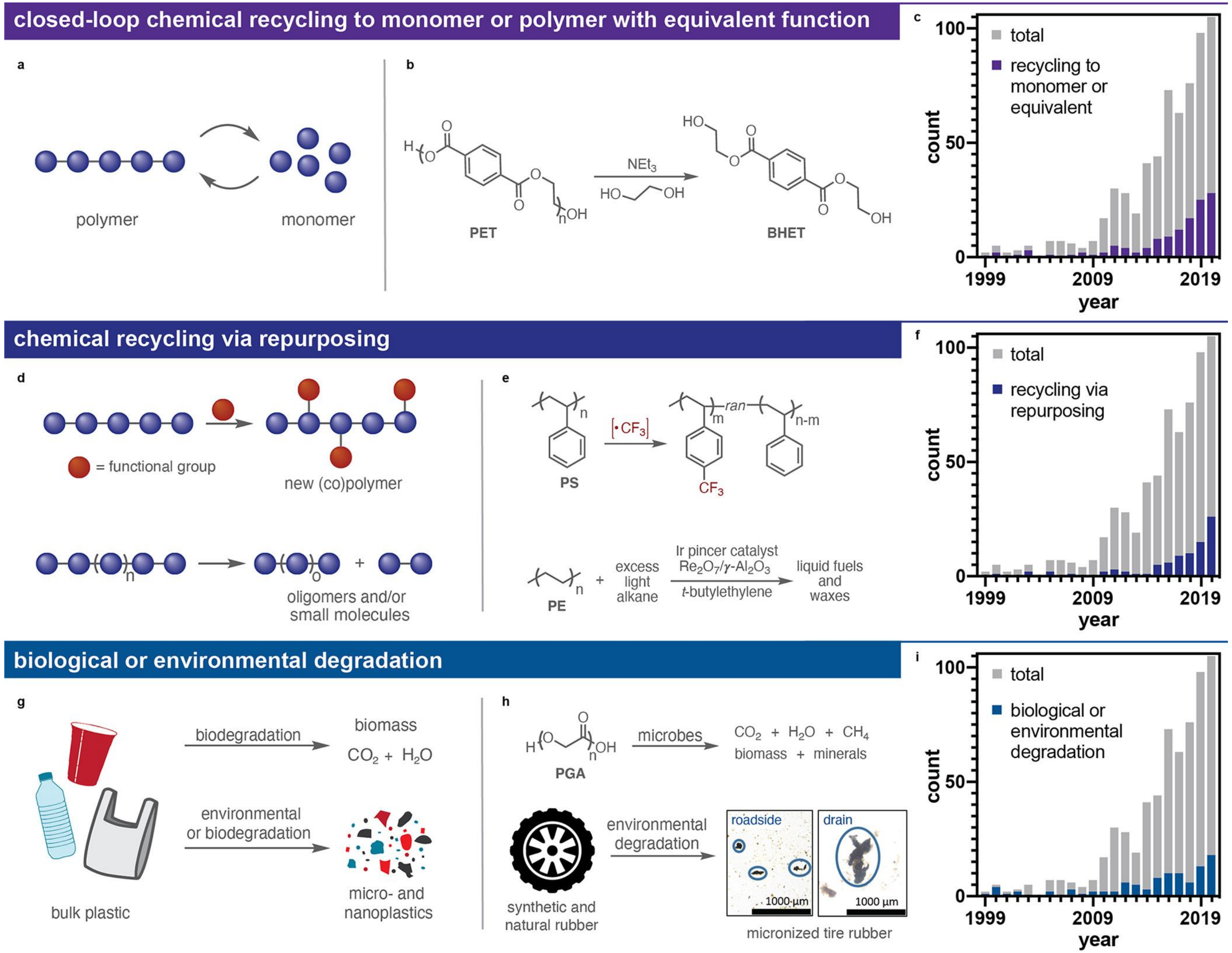
Journal of Cleaner Production 258 (2020) 120978
https://doi.org/10.1016/j.jclepro.2020.120978

Sustainable Polymers

Overview of end-of-life treatment categories

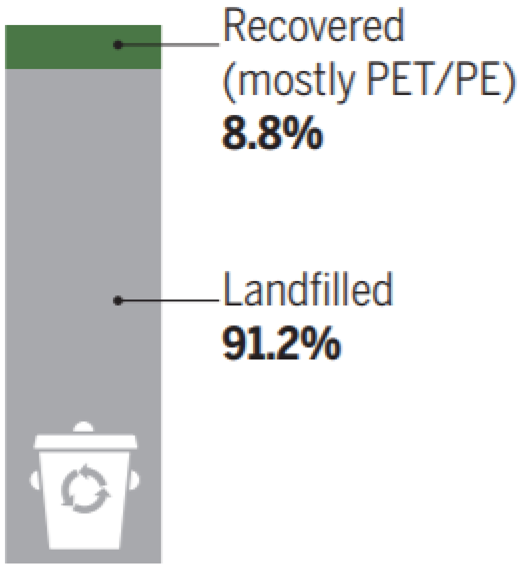
(a) Closed-loop chemical recycling to monomer or polymer with equivalent function
(b) example of depolymerizing PET into BHET;
(c) graphical representation of closed-loop chemical recycling observed in the surveyed literature;
(d) chemical recycling via repurposing to either modified polymer, oligomer, or small molecules;
(e) example of postpolymerization modification of PS reported by Leibfarth and co-workers(58) and fragmentation of PE into liquid fuels and waxes reported by Guan, Huang, and co-workers;
(f) graphical representation of chemical repurposing observed in the surveyed literature;
(g) biological or environmental degradation;
(h) example of PGA degradation reported and image of micronized tire rubber found in the environment

(i) graphical representation of biological or environmental degradation observed in the surveyed literature.



ACS Macro Lett. 2021, 10, 1, 41–53
DOI: 10.1021/acsmacrolett.0c00789

Recycling and upcycling of plastic wastes

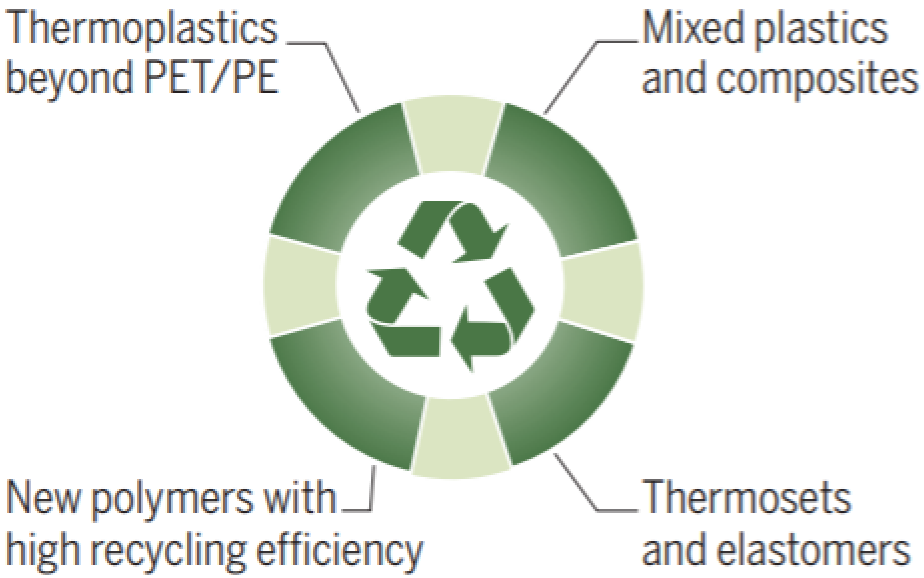


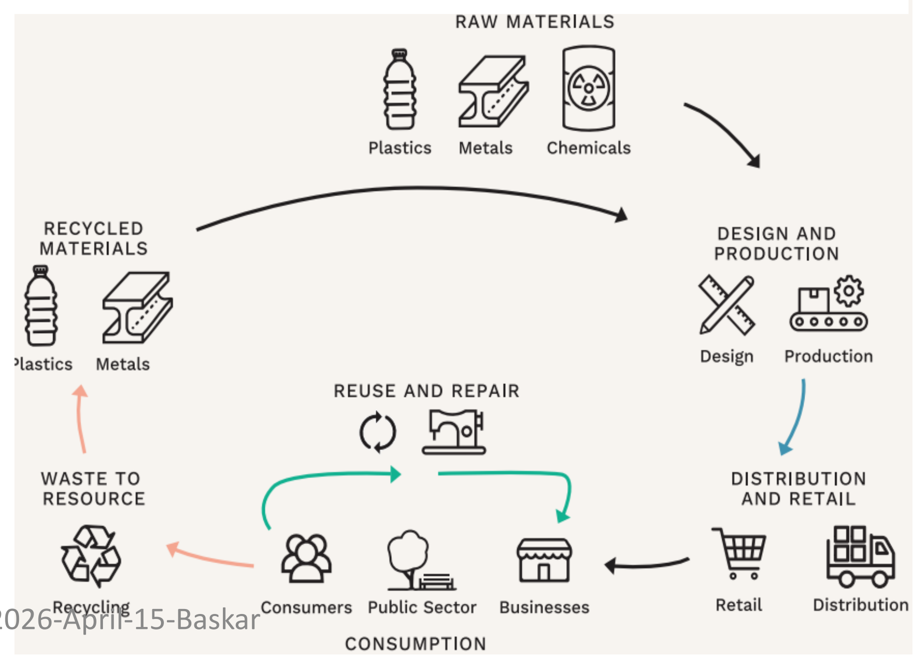
Current Plastic Waste Retreatment

Research advances

- New polymers
- Compatibilizers
- More efficient catalysts
- Advanced sorting

Recycling of diverse Polymers



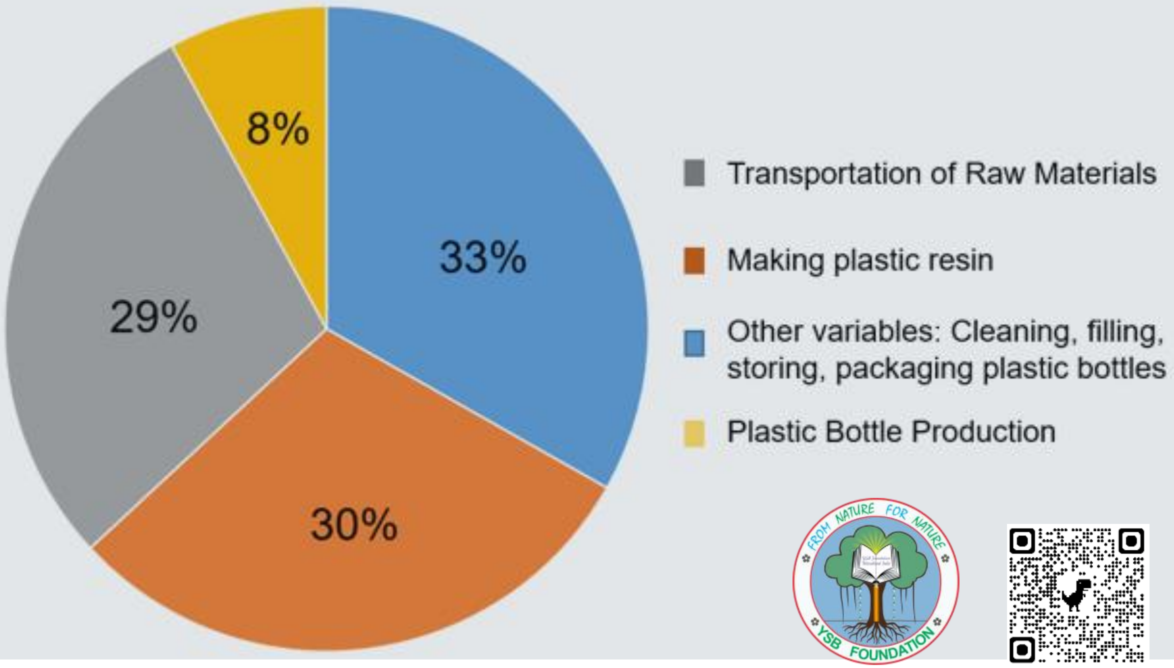


https://www.towardszerowaste.gov.sg/zero-waste-masterplan/

Recycling and upcycling of plastic wastes

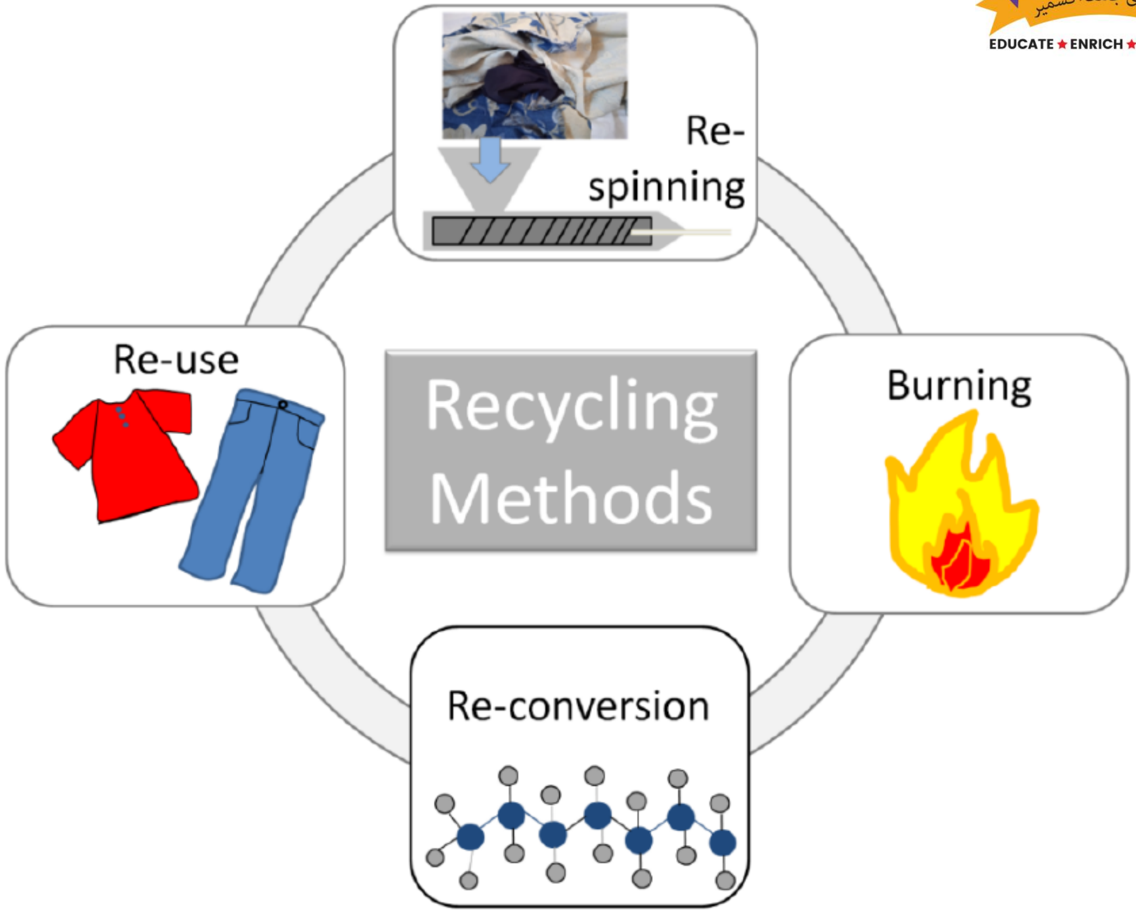
- The manufacture of one pound of PET (polyethylene terephthalate) plastic can produce up to three pounds of carbon dioxide.
- Processing plastic resins and transporting plastic bottles contribute to a bottle's carbon footprint in a major way.
- Estimates show that one 500-milliliter (0.53 quarts) plastic bottle of water has a total carbon footprint equal to 82.8 grams (about 3 ounces) of carbon dioxide.

PRODUCTION ALTERNATIVE: Recycling and Reuse can reduce carbon dioxide and other greenhouse gasses by an estimated 30 to 70%



Textile Waste and Textile Recycling Technologies

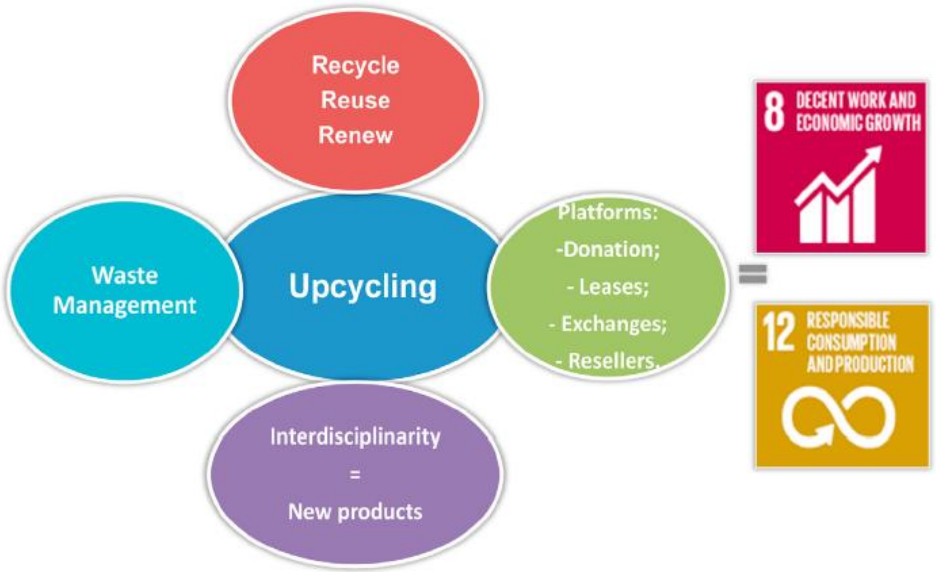
Examples of waste originated by textile world



Scheme of the Textile Recycling Technologies

https://doi.org/10.3390/polym13010134

Recycling and Upcycling of Textiles Waste: Circular Economy Approach to Sustainability



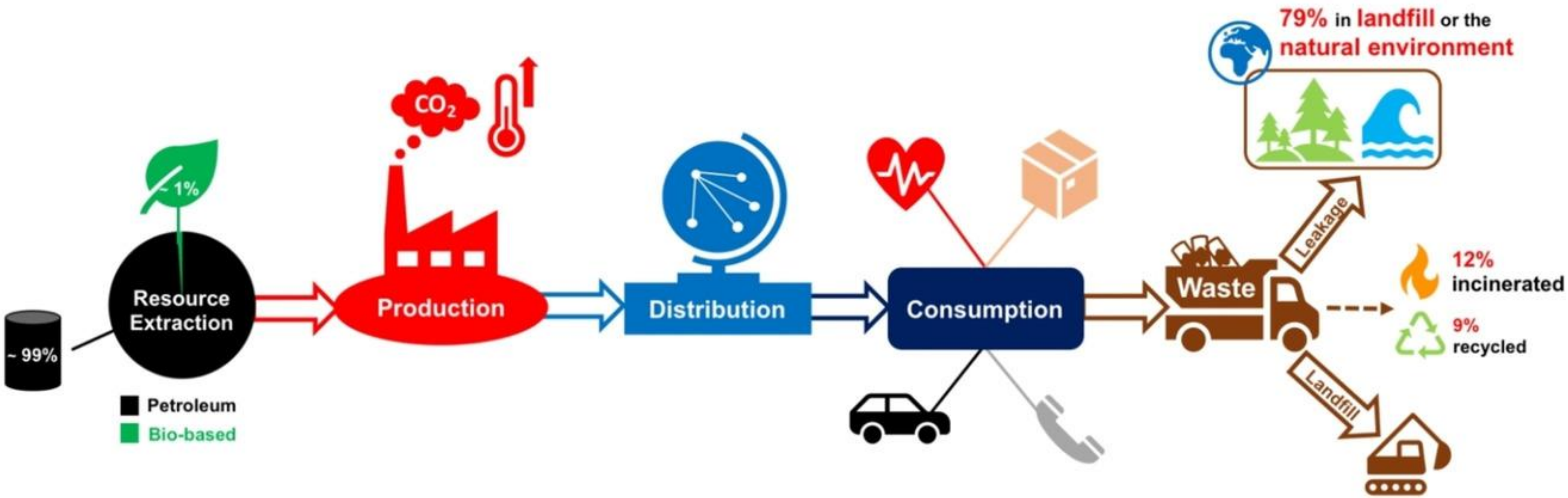
Upcycling and their relationship with the SDGs of 2030 Agenda (UN)

https://doi.org/10.1016/j.jclepro.2020.124444

The Chemical Recycling of Polyesters for a Circular Plastics Economy: Challenges and Emerging Opportunities

doi.org/10.1002/cssc.202100400

Linear Plastics Economy



Linear model of a petroleum-based plastics economy

ChemSusChem 2021, *14*, 1– 31; doi.org/10.1002/cssc.202100400

Circular Plastics Economy

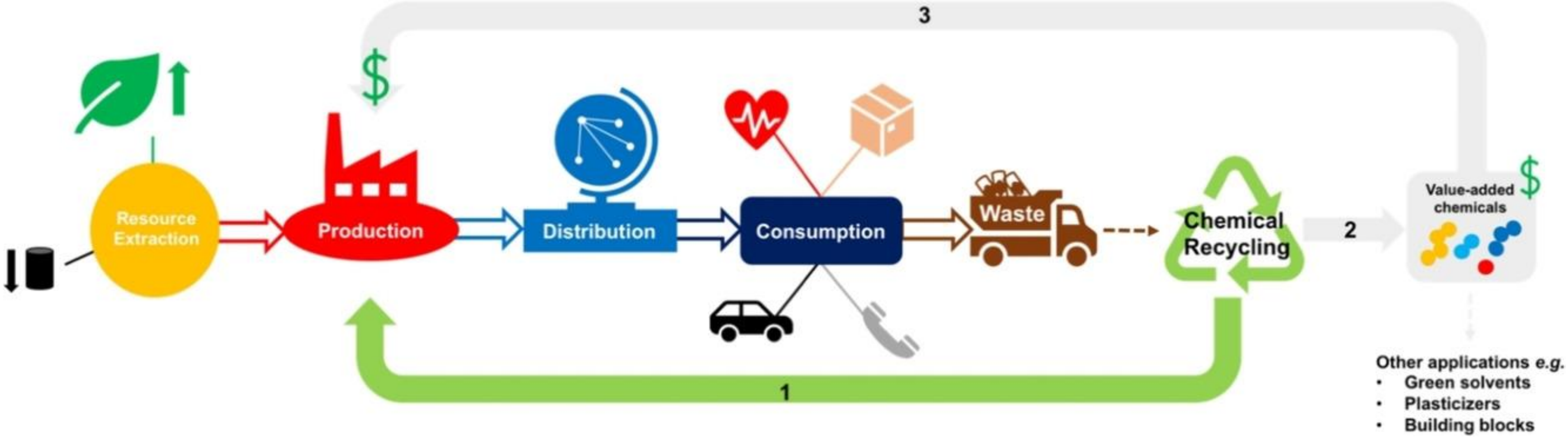


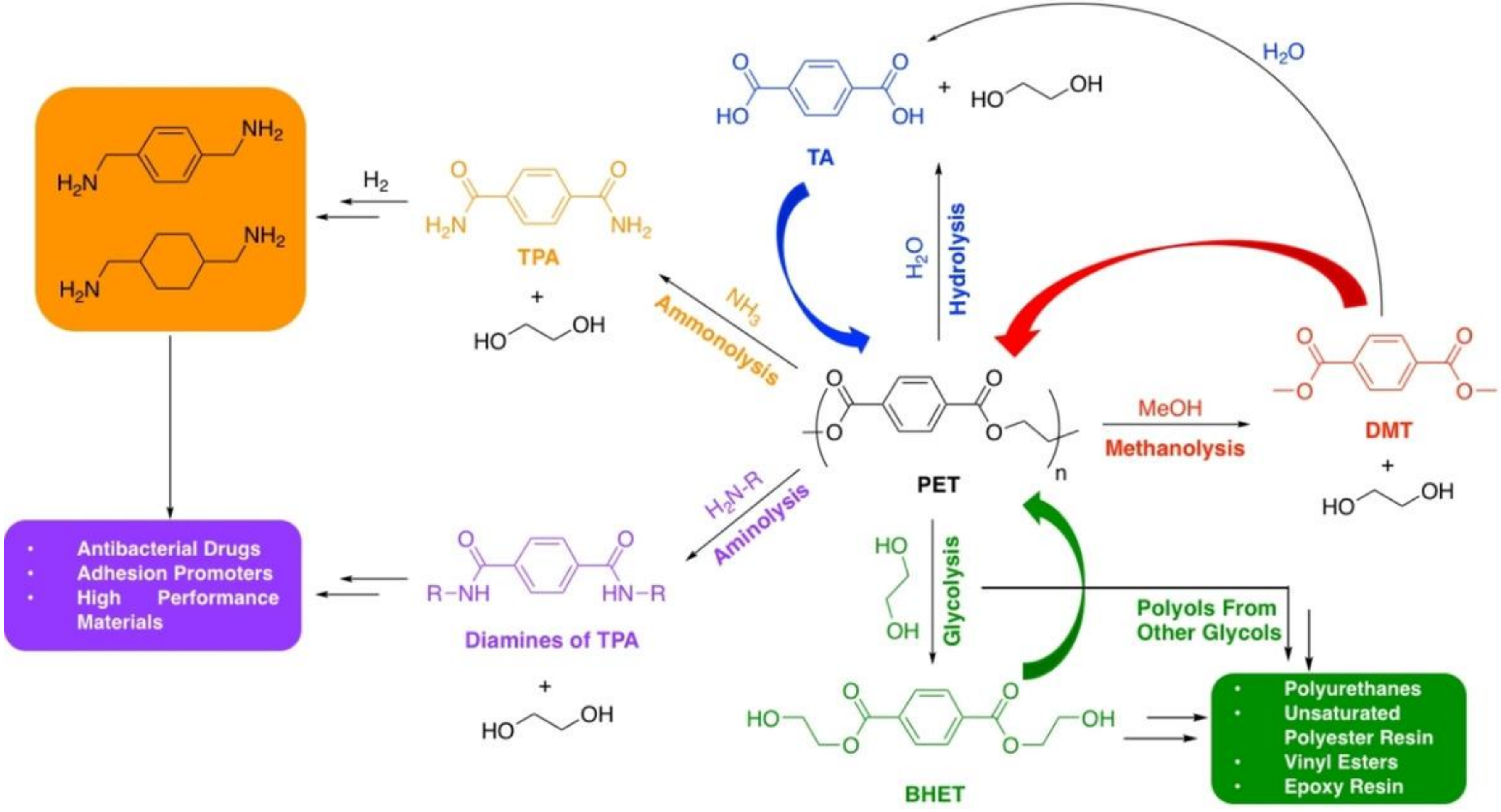
Diagram representing the potential for chemical recycling to introduce circularity into the plastics economy:

(1) closed-loop recycling or

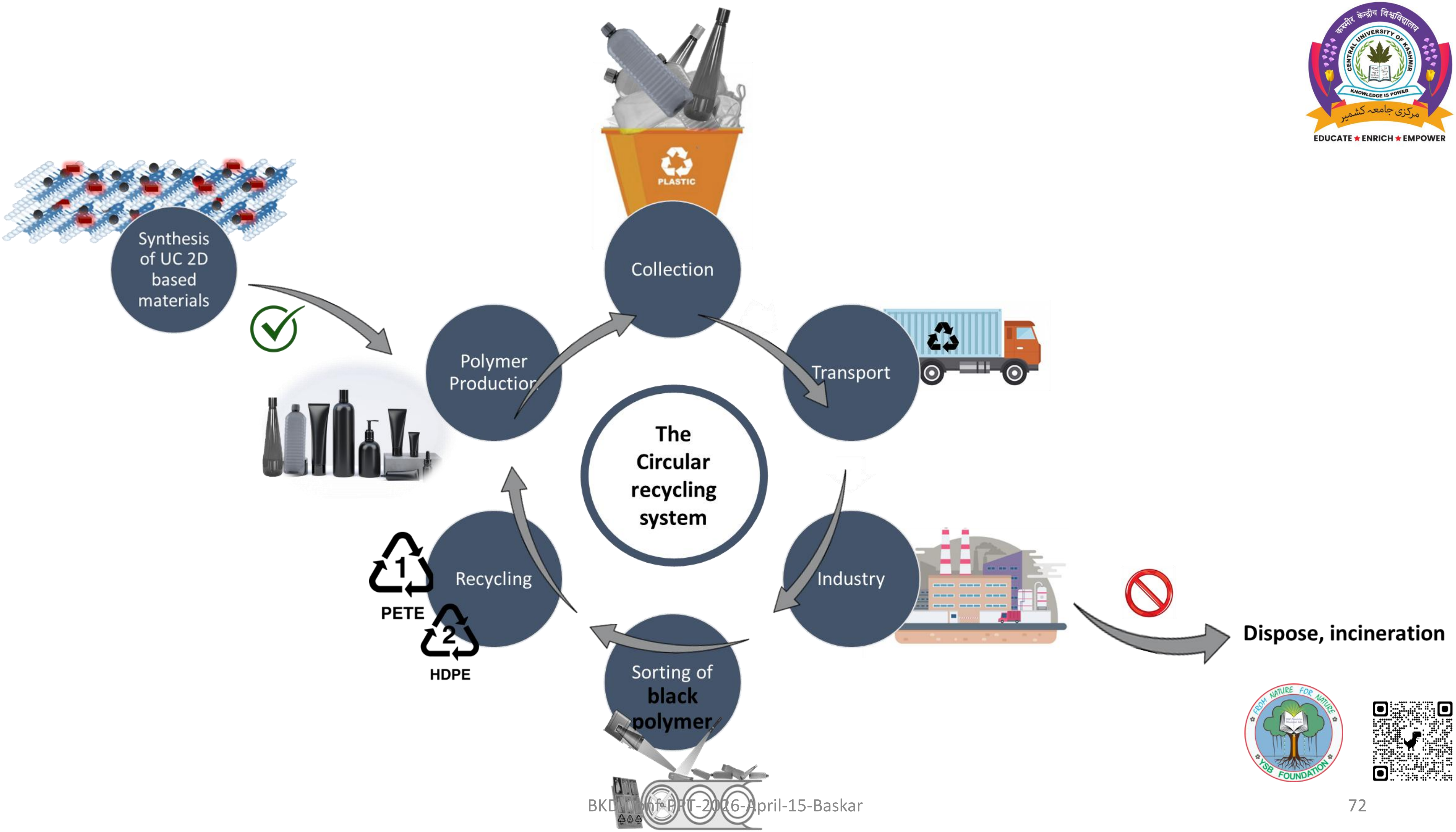
(2) transformation of plastic waste into value-added chemicals that can be used in higher-value applications or

(3) recirculated to access higher-value plastics

ChemSusChem 2021, *14*, 1– 31; doi.org/10.1002/cssc.202100400



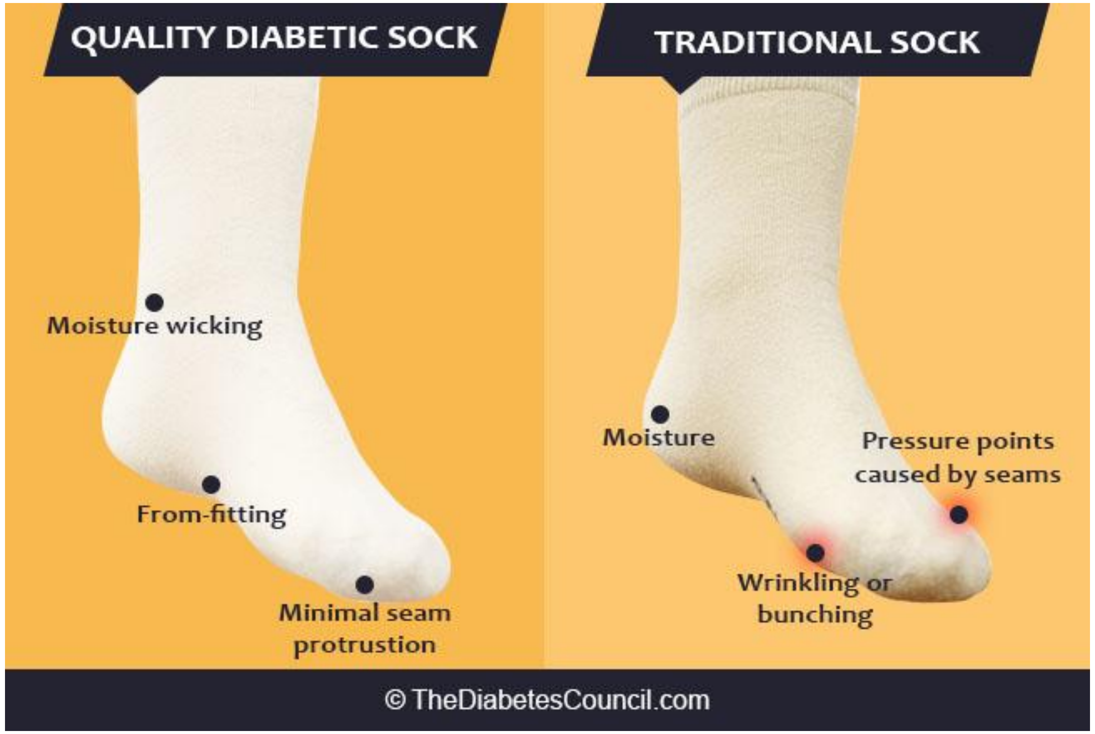
Summary of chemical recycling options for PET with example applications of value-added products. Note: green, red and blue arrows denote recycled products directly amenable to polymer reprocessing.



PLASTIC
Collection
Transport
Industry
Sorting of black polymer
Recycling
Polymer Production
Synthesis of UC 2D based materials
The Circular recycling system
1
PETE
2
HDPE
Dispose, incineration

Green Polymers and Smart Textiles

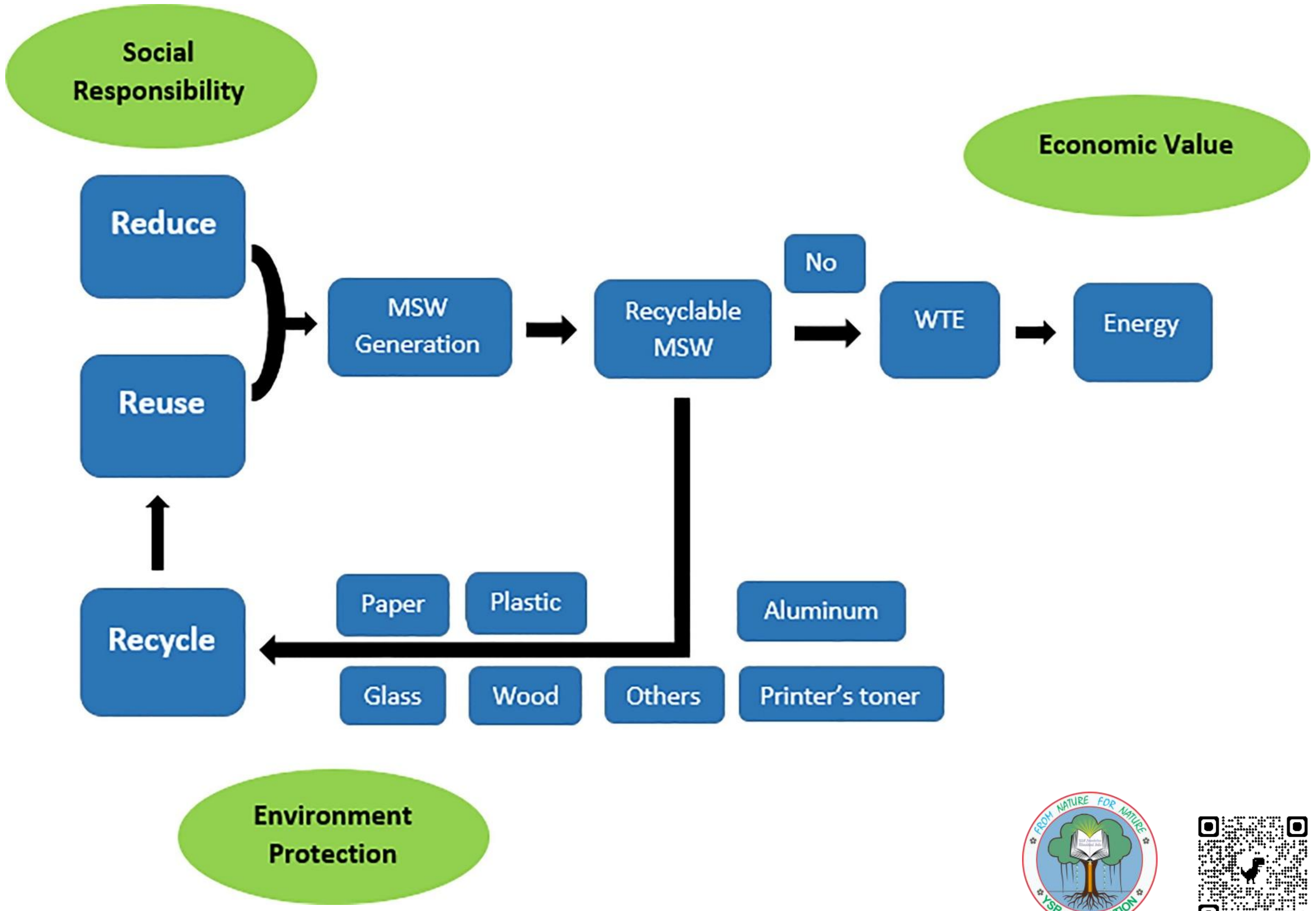
Synthet~~ic Pol~~ymers



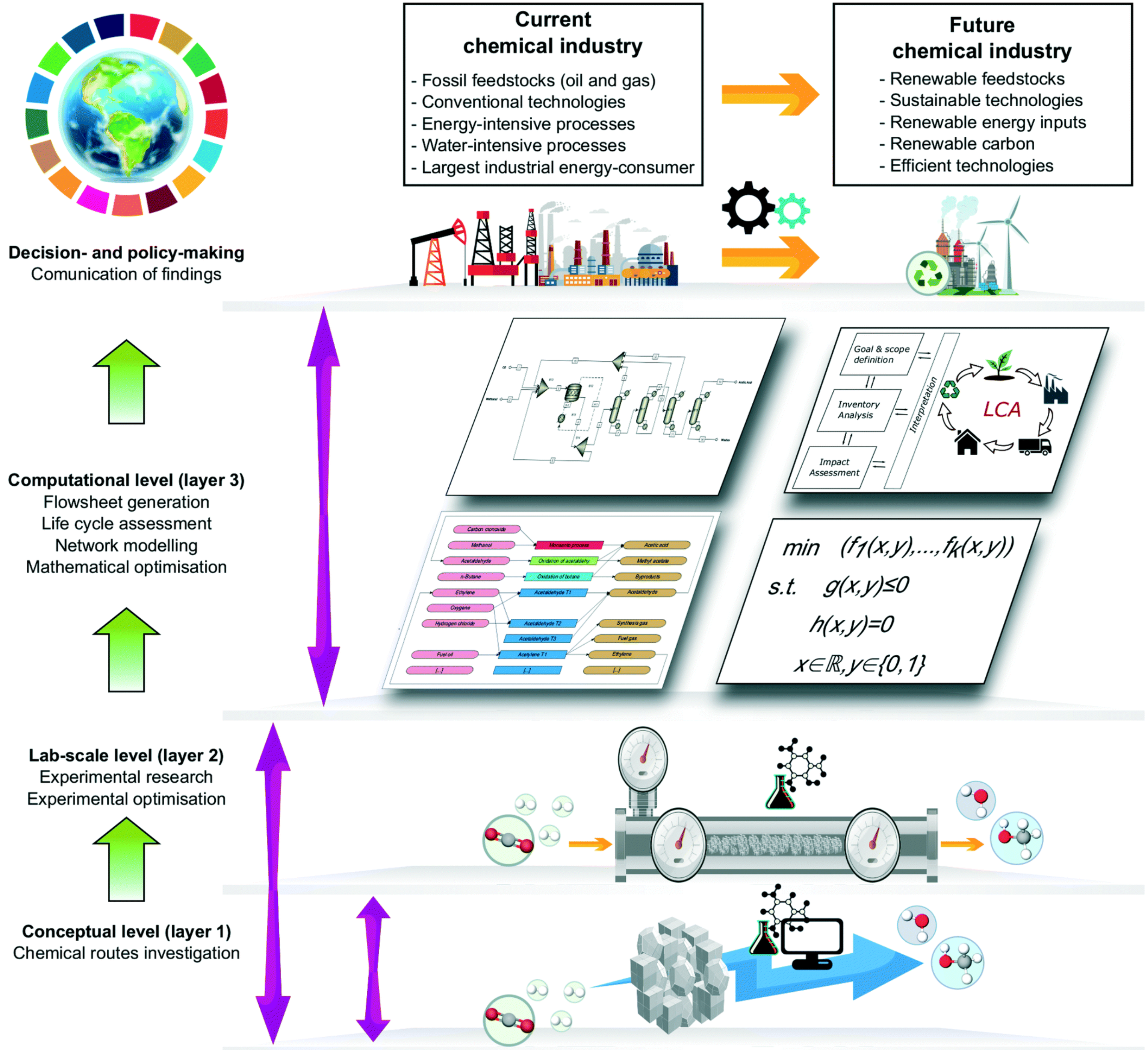
Green Polymers

Smart Textiles

An overview of MSW Management Recommendations



2021, 28, 3284–3293; https://doi.org/10.1016/j.sjbs.2021.02.072



The transition toward an environmentally friendly chemical industry

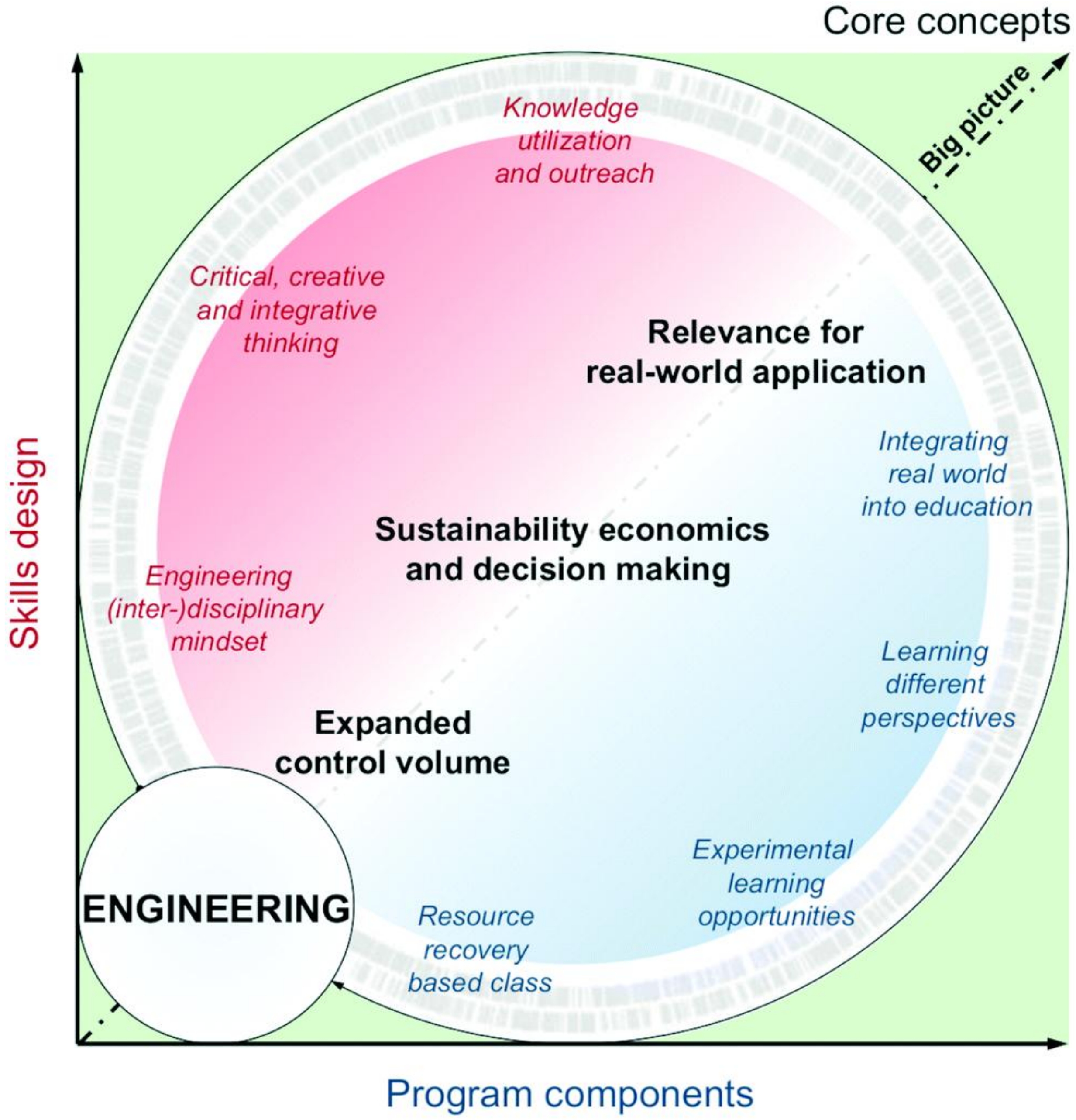
Three-level approach to sustainable chemicals and fuels:

(i) Molecular modelling and conceptualization of pathways

(ii) experimental research (at the lab-scale) and

(iii) process modelling (process simulation, life cycle assessment and network modelling).

React. Chem. Eng., 2021, Advance Article; DOI: 10.1039/d0re00451k



Core concepts (black), program components (blue), and skills design (red) to shape the 'genome' of the next generation of sustainability engineering leaders via tailored educational curricula for resource recovery and circularity.

Environ. Sci.: Water Res. Technol., 2020, 6, 1952–1966
DOI: 10.1039/d0ew00402b

Summary of the transition from Education 1.0 to Education 4.0

- ❖ **Education 2.0: Lesson Plans**
- ❖ **Education 3.0: Learning Plans**
- ❖ **Education 4.0: Learning & Creativity Plans**

A **new pedagogical paradigm shift** is required to change the **conventional teaching**, learning and curriculum framework to **circular teaching methodology** with blended mode of teaching and learning, students and teacher interactive session, critical thinking and analysis, practical approach, skill development and industrial oriented curriculum framework with **Sustainable Development Goals (SDGs)**.

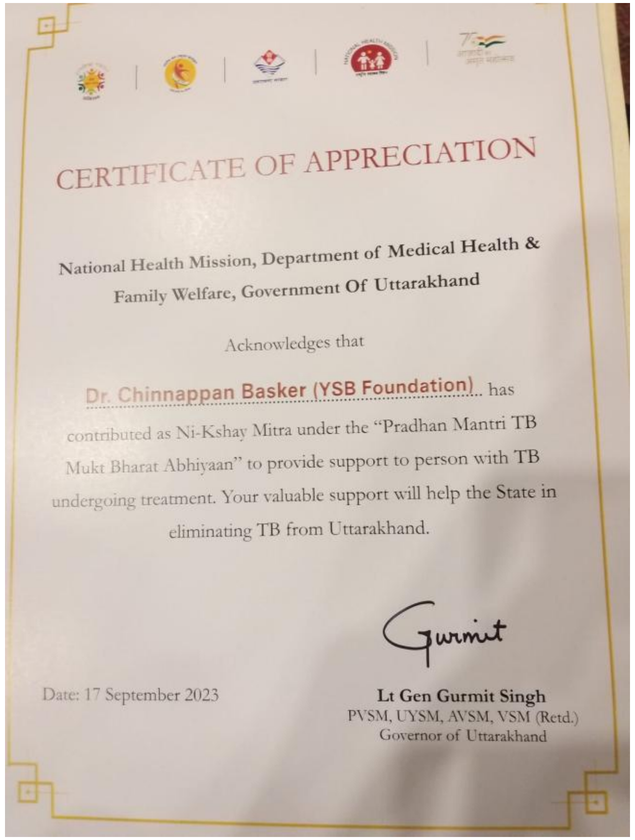
	Education 1.0	Education 2.0	Education 3.0	Education 4.0
Period	Late 18th Century	Early 20th Century	Late 20th Century	Present
Philosophy	Essentialism, behaviorism, and instructivism	Andragogical, constructivist	Heutagogical, connectivist	Heutagogical, peeragogical and cybergogical
Educator role	Sage	Guide, information source	Orchestrator, curator and collaborator	Mentor, coach, collaborator, reference
Student role	Largely passive	Emerging active "owning of the knowledge"	Active, "Knowledge ownership", initial independence	Active, high independence, trajectory designer
Approach	Teacher-centered	Peer assessment encouraged, high teacher importance	Co-constructed, first student-centered	Mostly student-centered
Learning outcome	Grades, graduation degree	License to professional practicing	Prepared for practice and scenario analysis	Training of key competencies both soft and hard
Enablers	Mechanical printing, graphite pencil, ballpoint pen, typewriter	First computers, electronic devices and calculators	Computers and widespread use of the internet	ICTs tools and platforms powered by IoT
Information source	Standard texts	Adopted texts and open-source material (physical)	Texts, case studies, second hand experience	Based on online sources
Facilities	Universities / classrooms	Blended laboratories and classrooms	Blended and flexible physical shared spaces	Cyber and physical spaces both shared and individual
Industrial technology	Mechanical systems, steam powered	Mass production, industrialization and electricity	Internet access, automatization and control	Connectivity, digitalization and virtualization

https://doi.org/10.1016/j.compeleceng.2021.107278

Integrated Solid Waste Management: Waste to Wealth through Circular Chemistry and Circular Economy | Start-ups Projects: Pilot Scale | Micro Scale | Large Scale

- ❖ Biogas from Solid Waste
- ❖ Plastic Waste Recycling
- ❖ Waste Cloth Recycling
- ❖ Paper Recycling
- ❖ Sanitary Pad Waste Recycling
- ❖ Solid Waste to Energy
- ❖ Solid Waste to Value Added Products

- ❖ **Food Waste to Biogas**
- ❖ Agricultural Waste to Value Added Products
- ❖ Green Hydrogen from Solid Waste
- ❖ E-waste Recycling
- ❖ Recycling of cans and steel
- ❖ Rubber Waste Recycling
- ❖ Glass Recycling


CERTIFICATE OF APPRECIATION

National Health Mission, Department of Medical Health & Family Welfare, Government Of Uttarakhand

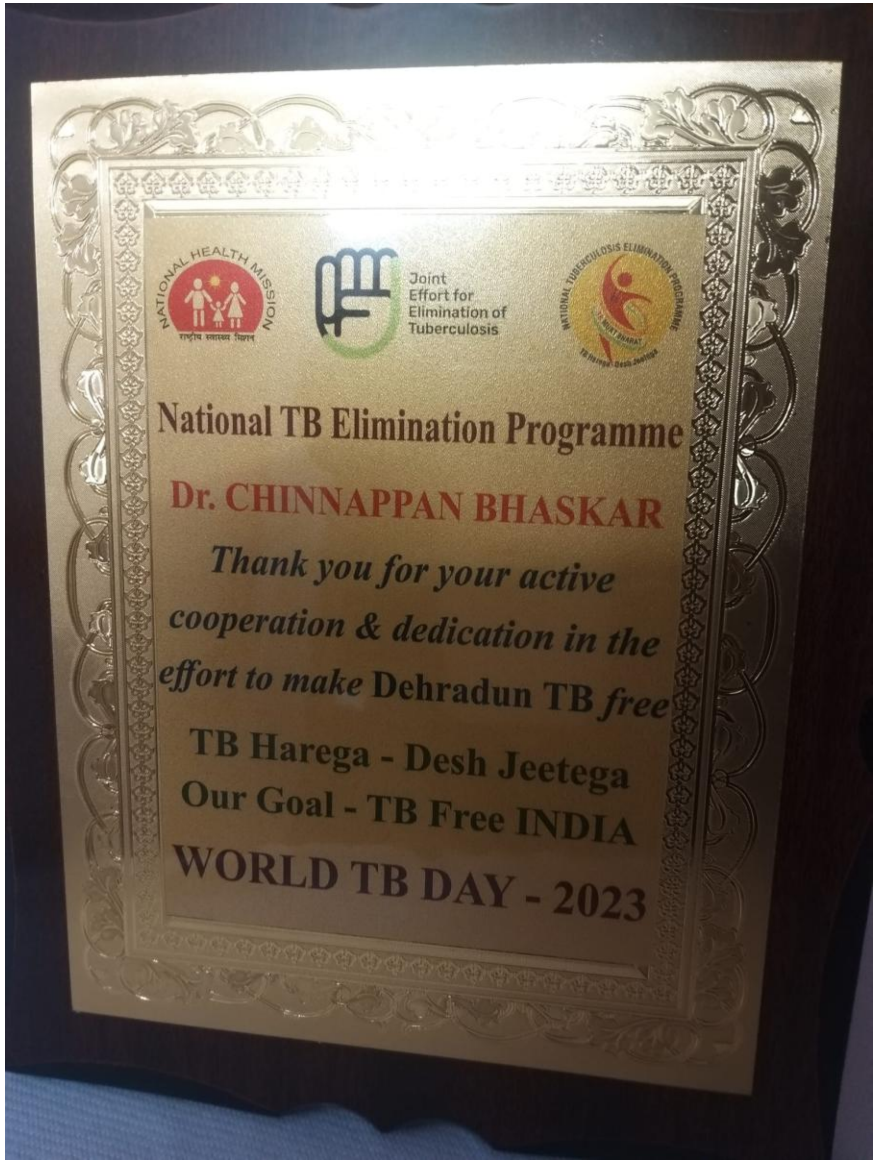
Acknowledges that

Dr. Chinnappan Basker (YSB Foundation) has contributed as Ni-Kshay Mitra under the "Pradhan Mantri TB Mukt Bharat Abhiyaan" to provide support to person with TB undergoing treatment. Your valuable support will help the State in eliminating TB from Uttarakhand.

Gurmit

Date: 17 September 2023

Lt Gen Gurmit Singh
PVSM, UYSM, AVSM, VSM (Retd.)
Governor of Uttarakhand



Joint Effort for Elimination of Tuberculosis
National TB Elimination Programme
Dr. CHINNAPPAN BHASKAR
Thank you for your active cooperation & dedication in the effort to make Dehradun TB free
TB Harega - Desh Jeetega
Our Goal - TB Free INDIA
WORLD TB DAY - 2023

2023
DugGu Shah | Dehradun,Garhwal Division | 2023.03.25 17:32

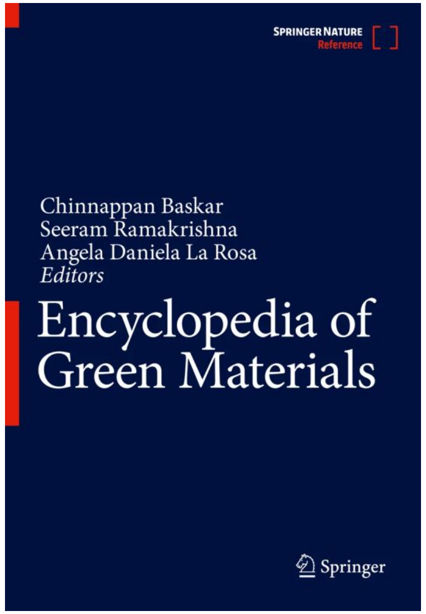

24 Hours
"रक्तदान"

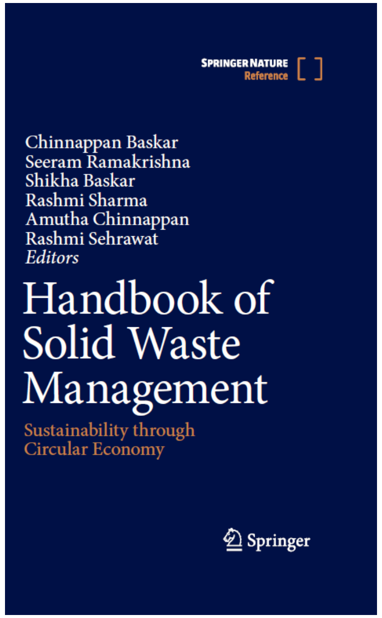

BLOOD CENTRE
24 Hours

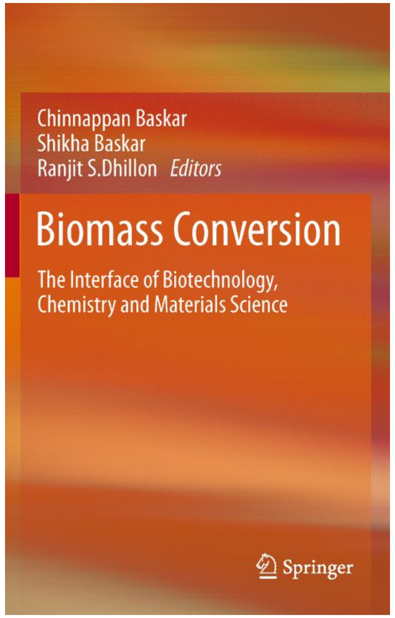

BLOOD CENTRE


VANSH COMFORT
CHAIRS

"This is not the end. It is not even the beginning of the end. But it is, perhaps, the end of the beginning." – **Sir Winston Churchill**

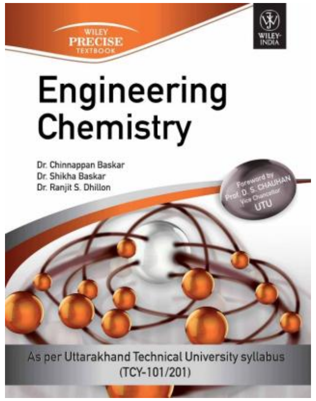


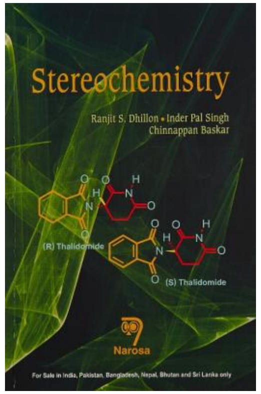


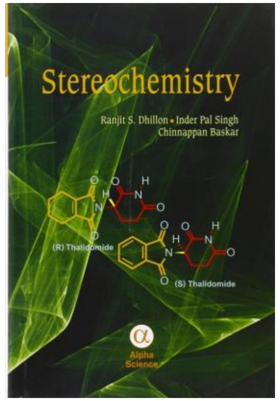


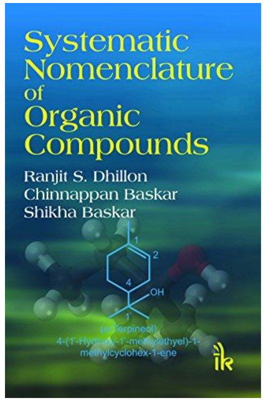
Chemistry Website QR

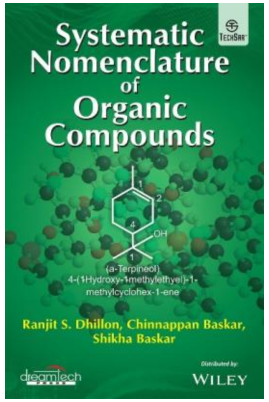
Thank You











Have an awesome day!

"With the spirit of love, dedication, will power, creativity, and hard work; everything is possible in the world." – **BaSKAr, C.**