General information on Bio degradable and compostable plastic

The value of Bio-materials

2024.

CJ CheilJedang

White BIO

1. Plastics –Why we concern?

Environmental Pollution

Low Recycle Rate

Potential Risks on Life

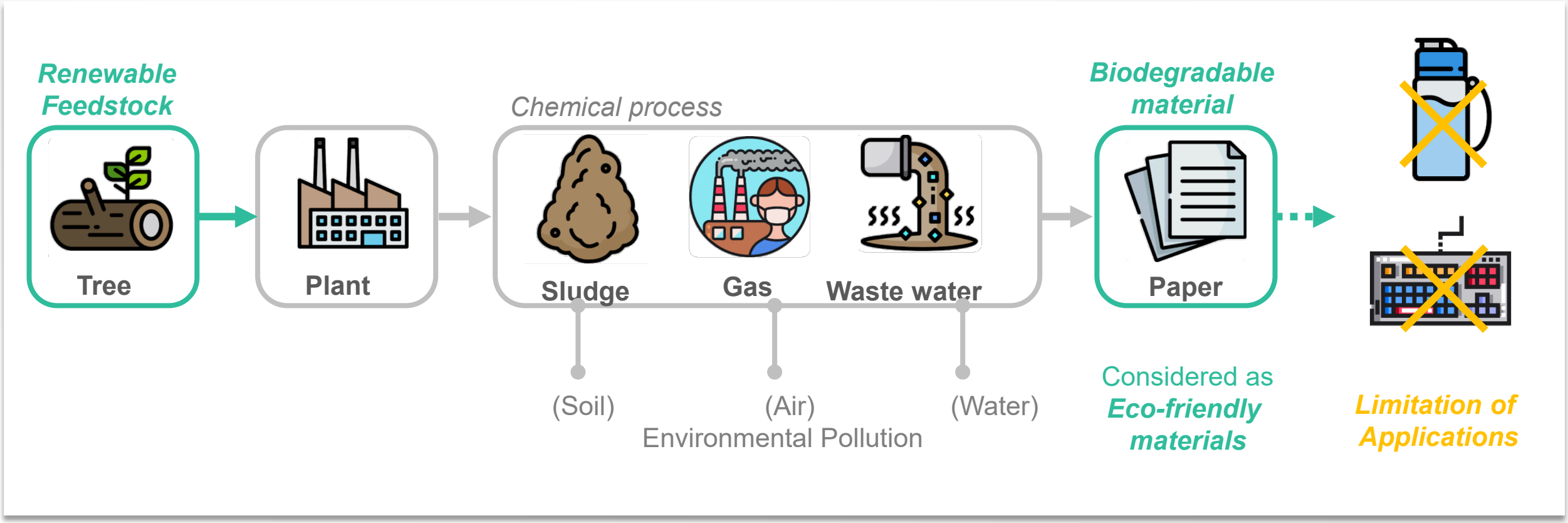
What could be the effective alternatives?

Ref. Bioplastic production in terms of life cycle assessment A state-of-the art review(2023)

2. Examples of sustainable alternatives: paper

Despite of polluting nature during manufacturing process, paper is considered as an eco-friendly solution because of its biodegradable property and the use of renewable feedstock

[Pulp & Paper Process]

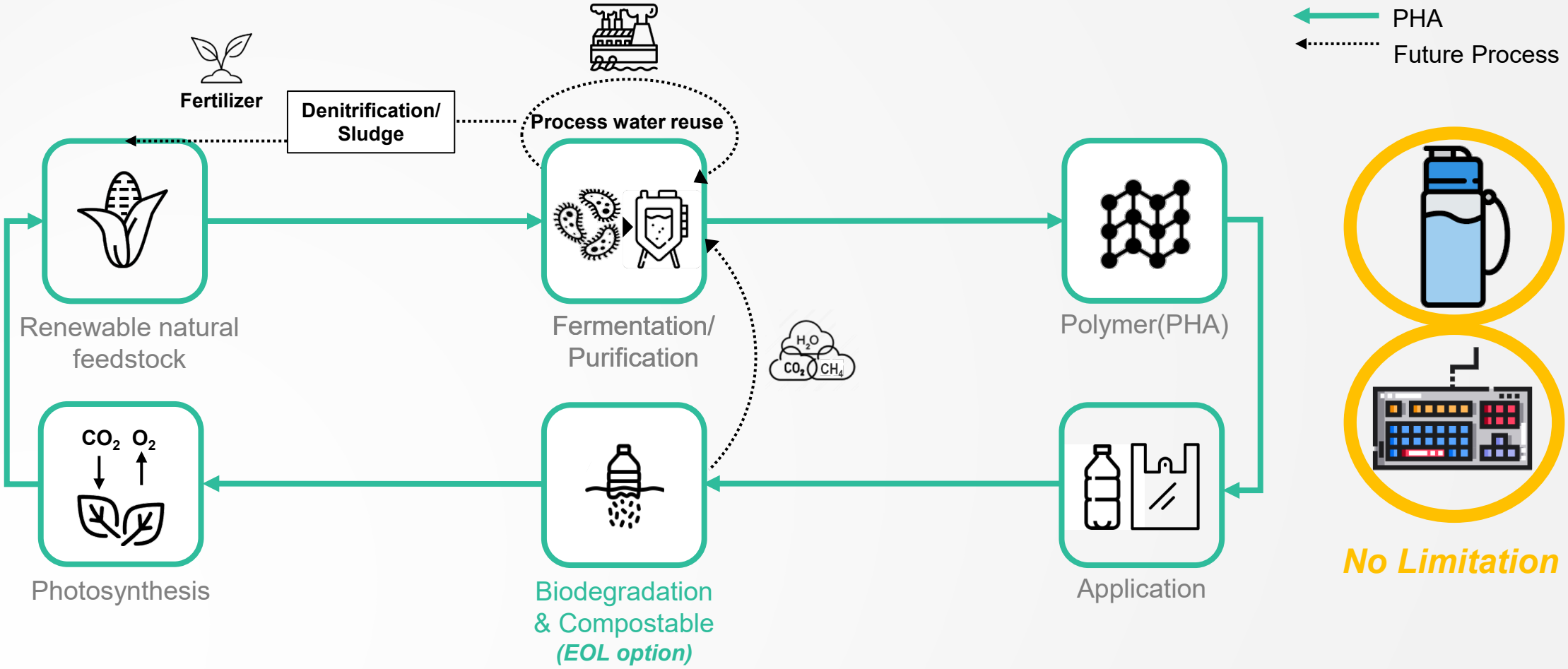


Ref. Environmental pollutants of paper industry wastewater and their toxic effects on human health and ecosystem (2022)

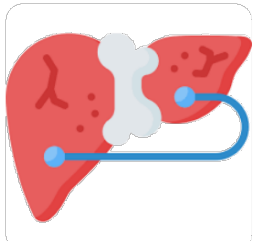
2. Examples of sustainable alternatives: Bio degradable/compostable plastic

Bio degradable/compostable plastic hold the potential to replace the traditional, linear lifecycle of plastic with a **fully circular solution**

[PHA Process]

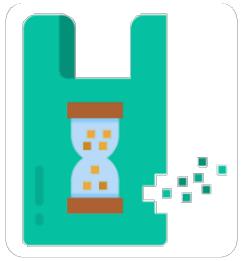


3. PHACT – Natural material?



Biocompatibility

Do not exert any toxic or elsewhere negative effect to living cells or tissue of humans or animals… (Ref.1)



Biodegradable in all reasonable natural environment conditions

PHA is Biodegradable under industrial, Home, Soil and Marine conditions

PLA, PBS, PBAT is Biodegradable under industrial, Home and Soil conditions

Low Microplastics Issue

Small-sized PHA particles are not resistant in nature; they undergo biodegradation and do not leave any remnants. Hence, secondary microplastics" consisting of PHA biopolymers simply do not exist (Ref.2)

Better LCA

PHA has a better life cycle assessment (LCA) score compared to other biomaterials and petroleum-based plastics

PHA(P3HB) -2.3 / PLA 0.5 / PP 1.5 / PET 2.4 (Ref.3)

Ref. (1) Biodegradable and Biocompatible Polyhydroxy-alkanoates (PHA): Auspicious Microbial Macromolecules for Pharmaceutical and Therapeutic Applications (2018), (2) Microbial PolyHydroxyAlkanoate (PHA) Biopolymers—Intrinsically Natural (2023), (3) Bioplastics for a circular economy (2022)

3. PHACT – Natural material?

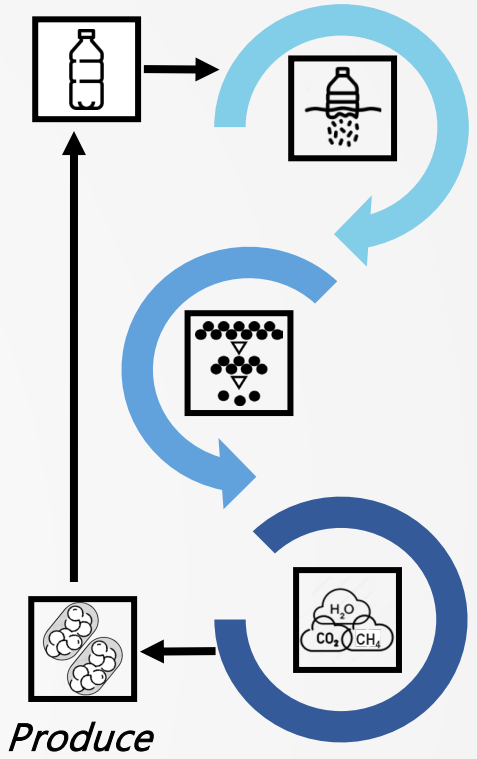
Low Microplastics Issue
Small-sized PHA particles are not resistant in nature; they undergo biodegradation and do not leave any remnants. Hence, secondary microplastics" consisting of PHA biopolymers simply do not exist (Ref.2)

[Biodegradable material features]

● Biodegradable △ Conditionally biodegradable X Non biodegradable

	Natural	Conventional Synthesis	Synthesis		
	PHA	PLA	PBAT	PBS	Bio-PP
Industrial Composting	●	●	●	●	X
Home Composting	●	△	△	△	X
Biodegradable soil	●	△	△	△	X
Biodegradable Marine	●	X	X	X	X
Anaerobic Digestion	●	●	●	●	X

[Biodegradation Process]



- **Abiotics Degradation**
  - Thermal, Chemical, Mechanical, Photo
  - **Microplastics Generation**
- **Bio Fragmentation**
  - Depolymerization
- **Assimilation**
  - Production of Energy, Biomass

4. Possible to replace plastics?

CJ PHA(PHACT) has been applied to a wide variety of commercial products across different Industries and contributed by **reducing issues with existing products and enhancing product sustainability**

commercial Products

BANILA CO.
Cleansing Balm
Cosmetic Jar

WAKEMAKE
Cushion Facts
Cosmetic Containers

CJ CheilJedang
Tofu Bundle
Film Wrapper

Diverse companies
(Twosome Place etc.)
Disposable straws

PHA straw

Paper straw
(Using glue,
Low consumer satisfaction)

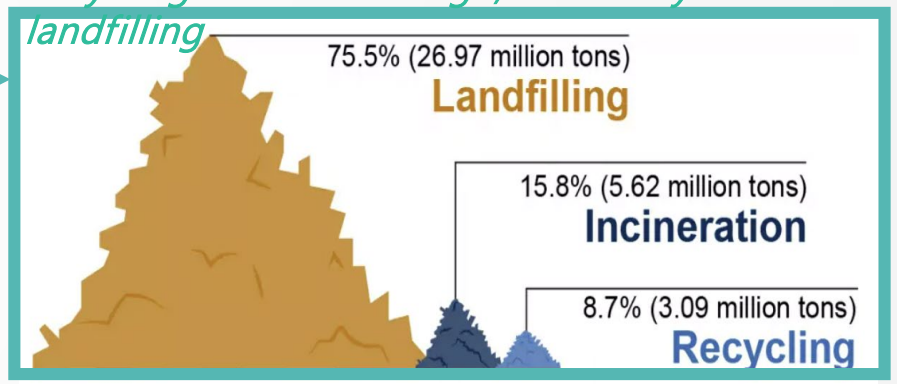
Plastic straw
(Environment
problem)

5. Why trustful material registration necessary – avoid green washing

Mechanical/Chemical Recycle

Non-recyclable plastics

Recycling rate not enough, Too many landfilling



1. *Ensuring the bio-degradability of a material is of utmost importance*
2. *It implies that biodegradation certification system holds significance as well*
3. *What if there are <u>no landfills</u>?*

Ref. GAO analysis of 2018 U.S. Environmental Protection Agency(EPA)

5. Why trustful material registration necessary – avoid green washing

The direct landfill ban is on the horizon... Expanding incinerators is still 'difficult'

January 23, 2023

'Compostable material' could be a solution!

<u>In 2026, from 3 years later, direct landfilling of rubbish in the metropolitan area will be banned</u>.
About 2,200 tons of this is incinerated in Seoul, and the remaining 1,000 tons are buried in a landfill in Incheon. However, it is only possible to send 1,000 tons to Incheon by 2025.
This is because direct landfilling has been banned from 2026 due to the amendment of the relevant enforcement regulations....

Ref. newsdirectory3(2023)

5. Why trustful material registration necessary – avoid green washing

For the growth of material solutions using new innovative technologies, it's imperative to have well-established **waste management system, certification process and regulation**

Revision of the Packaging and Packaging Waste Directive

Briefing 31-03-2023

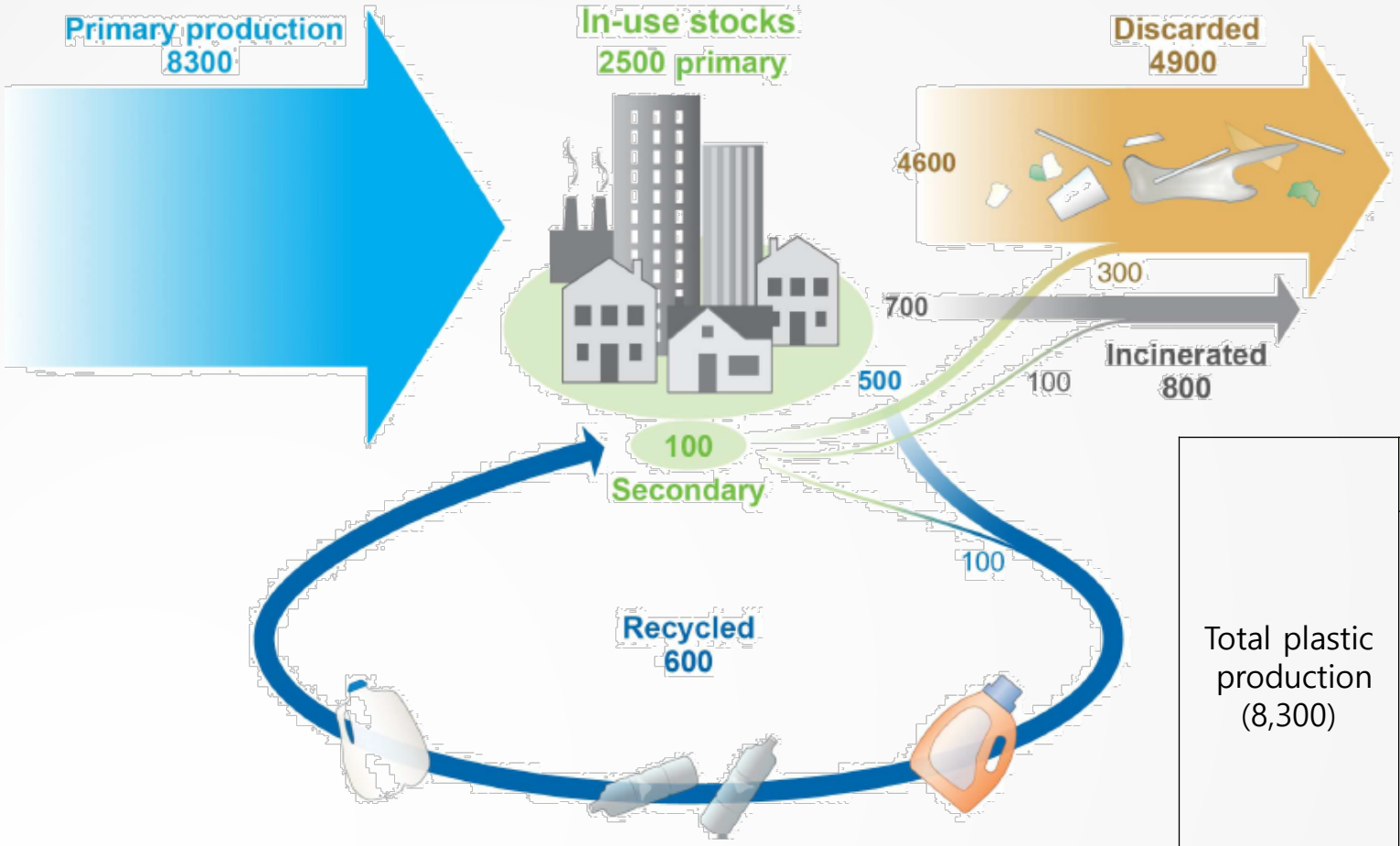
Some packaging items would have to be compostable in industrially controlled conditions in bio-waste treatment facilities within 2 years of the entry into force of the regulation: **tea or coffee bags, coffee or tea system single-serve units, sticky labels attached to fruit and vegetables and very lightweight plastic carrier bags**

Ex. Nespresso launches compostable coffee cups in line with EU regulations

Ref. European Parliament (2023)

6. Plastics –Why we concern?

Cumulative global plastic production is 8.3 billion ton since 1950, while **only 500 million ton of plastic(6%) are recycled**: Oversupply of plastic led to its overuse and mismanage



[1950 to 2015, in million metric tons]

Total plastic production (8,300)	In-Use stocks			**2,500**
	plastic used once (5,800)	Discarded		**4,600**
		Incinerated		**700**
		Recycled (500)	landfill after recycling	**300**
			Incineration after recycling	**100**
			recycle repeat	**100**

Ref. Sci. Adv. Production, use and fate of all plastics ever made(2017)


Thank You
CJ CheilJedang
White BIO

1. Plastics – Why we concern?

Plastics might have cause environmental pollution throughout their lifecycle, which could impact

ecosystem and human health

Cadmium, chromium, lead and mercury, which have previously been used in plastic production, are banned in many jurisdictions. However, they are still routinely found in some plastic packaging including food packaging

1. Production

2. Products

World Health Organization's International Agency for Research on Cancer (IARC) has recognized vinyl chloride, the precursor to PVC, as a human carcinogen

Incineration of plastic can produce harmful substances (such as POPs[1])

[1] POPs: Persistent Organic Pollutants

3. disposal

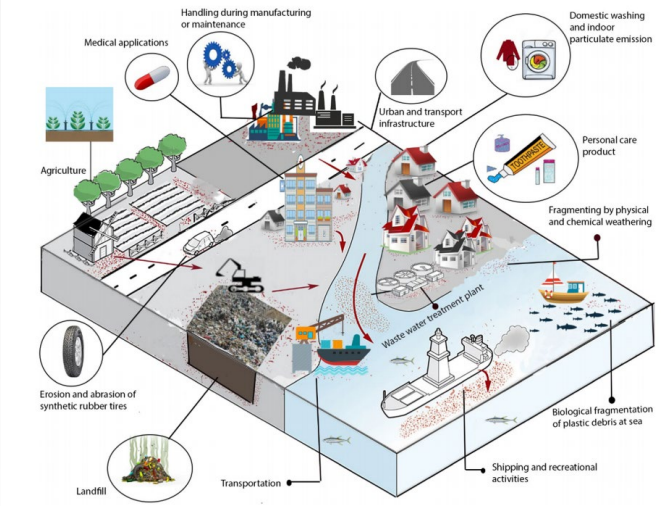
4. Health Effect

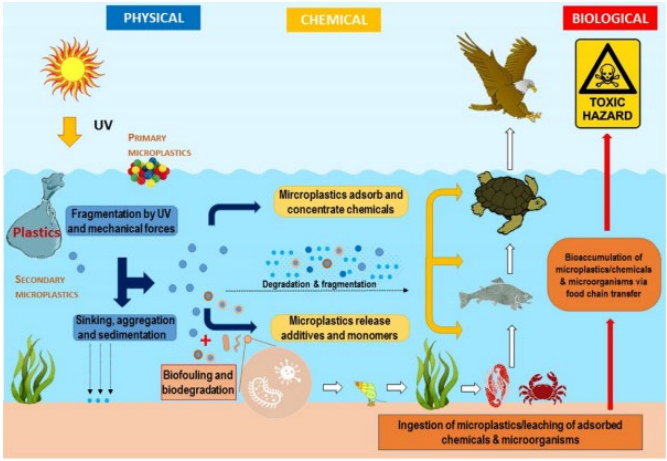
In 2023, plasticosis, a new disease caused solely by plastics, was discovered in seabirds. The birds identified as having the disease have scarred digestive tracts from ingesting plastic waste

Ref. Drowning in Plastics – Marine Litter and Plastic Waste Vital Graphics(2022)
New disease caused by plastics discovered in seabirds(2023)

1. Plastics –Why we concern?

Microplastics can be ingested by living organisms and accumulated in the body





Human Health Impacts of Exposure to Chemicals in Microplastics

Neurodevelopmental disorders
Attention deficit hyperactivity disorder (ADHD)
Autism
Neurobehavioral deficits
Decreased IQ
Cognitive deficits

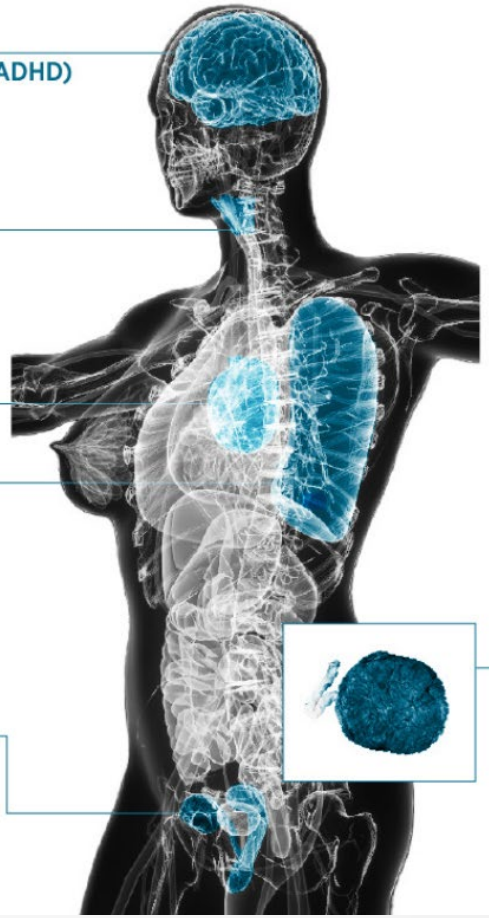
Hormonal diseases
Thyroid disease
Thyroid cancer

Cardiovascular disease

Respiratory diseases
Asthma

Male reproductive health impacts
Subfertility
Reduced sperm quality

Female reproductive health impacts
Polycystic ovarian syndrome
Endometriosis
Delayed time to pregnancy
Abnormal Pap smears
Pregnancy-induced hypertension and/or preeclampsia



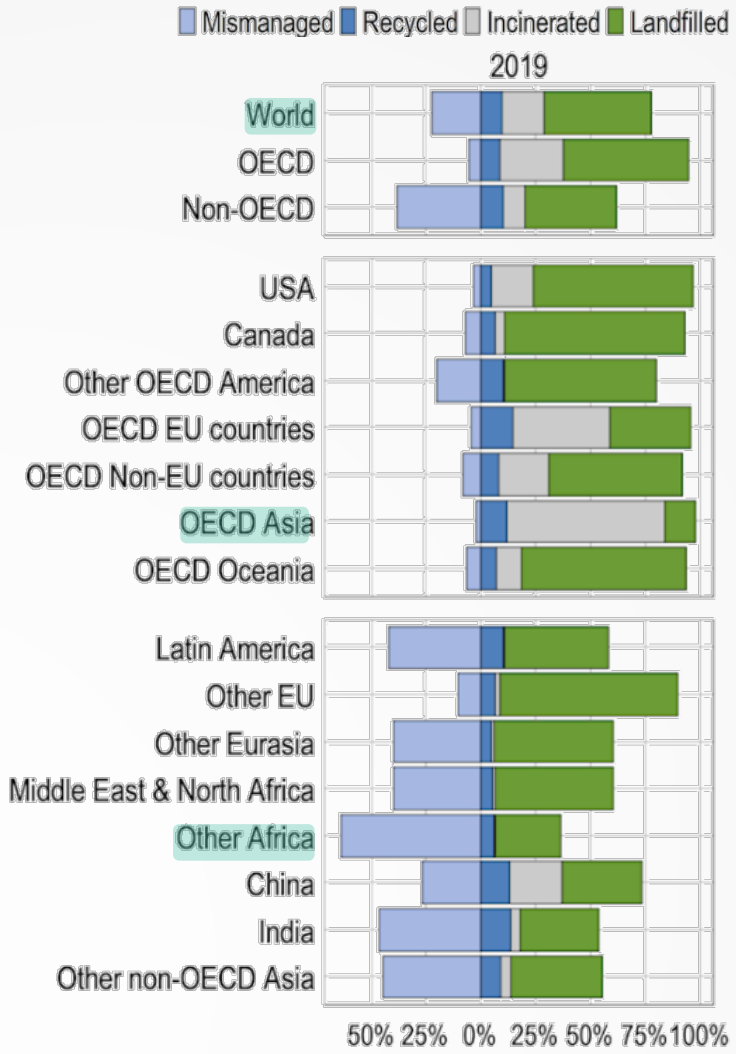
Metabolic disorders
Type 2 diabetes
Excessive childhood weight gain
Increased waist circumference
Serum lipid levels, e.g., total cholesterol and LDL cholesterol

Other health impacts
Decreased antibody response to vaccines
Physical damage
Carcinogen absorption

Pregnancy outcomes
Preterm birth
Lower birth weight
Abnormal genital structure (anogenital distance)
Altered pubertal timing

Ref. (1) Environ. Sci and Pollution Res 25, 36046(2018), (2) ACS Omega, Analysis and Prevention of Microplastics Pollution in Water:Current Perspectives and Future Directions(2019), (3) Env.Sci.Pollu.Research, Effect of microplastics in water and aquatic systems(2021), (4) From pollution to solution(2021)

Mismanaged plastic waste(2019)



- *World mismanaged plastic waste 22%*

- *Min 2%(OCED Asia)*

- *Max 63%(Other Africa)*

Ref. OECD ENV-Linkages model. (2017)

Nonclinical toxicity assessment

Nonclinical toxicity assessment

- **Nonclinical toxicity assessment**
  - Evaluate skin issues and allergic reactions to confirm the safety of skin-contact products
    : Passed systemic toxicity, cytotoxicity, irritation and skin sensitization test

Test	Test Standards	Overview
Systemic toxicity test	ISO 10993-11	Assess clinical signs and weight loss in rodents to determine acute systemic toxicity.
Cytotoxicity test	ISO 10993-5:2009(E)	Determine cytotoxicity of test substances using L-929 mouse fibroblasts
Irritation test	ISO 10993-10:2010(E)	Evaluation of local irritation or toxicity at the site of administration when administered intradermal in rabbits
Skin sensitization test	ISO 10993-10:2010(E)	Evaluate contact allergencity of test substances in guinea pigs

Systemic toxicity test

Cytotoxicity test

Irritation test

Skin sensitization test