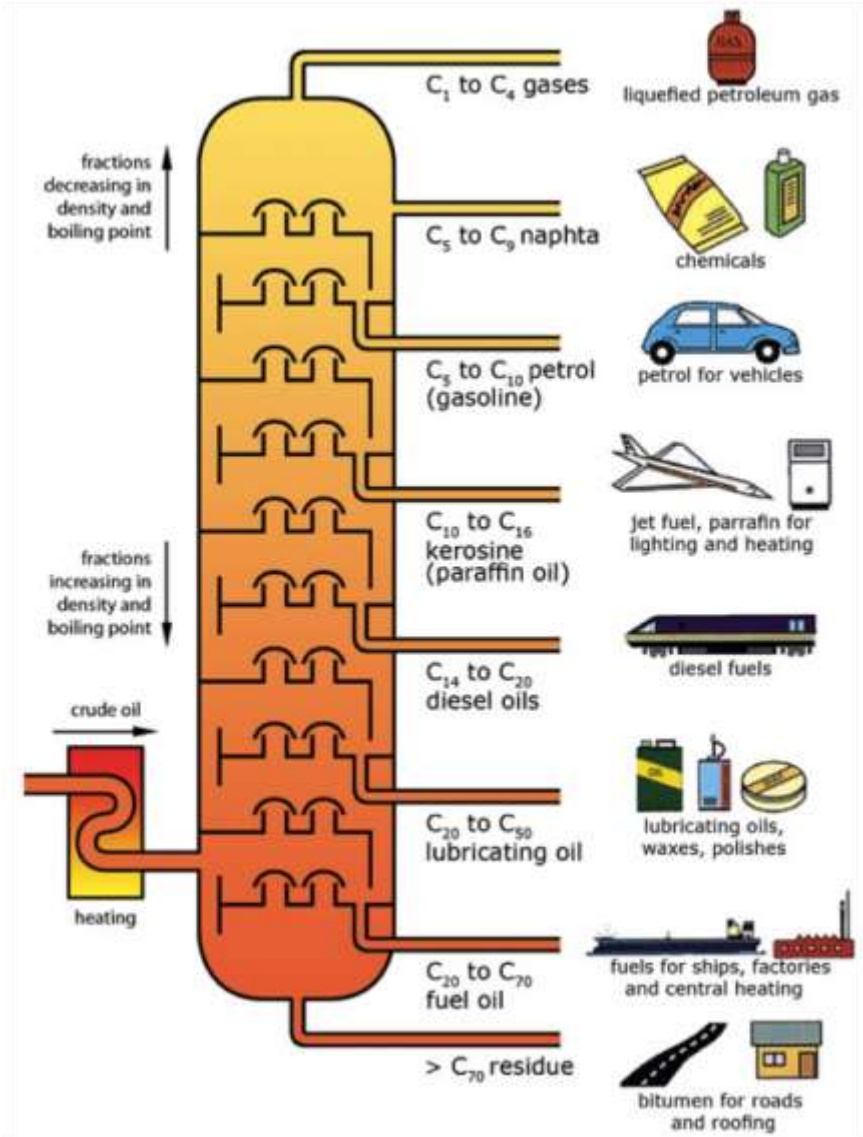
Chemistry of Plastics

Plastics are synthetically generated through polymerization of mainly ethylene derived from cracking lighter fractions and naphtha.



Plastics –Positive and Negative

- Durable ,
- Low weight material ,
- Strong as metals .
- Ease in converting to required shape ,
- Appeals aesthetically yet can be subjected to rough use
- Is recyclable, economic, A Miracle..
- **Negative impact of plastic**
- Accumulate as garbage on the planet..
- Bio Non degradable
- Emit fumes which contain harmful chemicals on burning

Recyclable home plastics

	**Number 1** • *PETE or PET (polyethylene terephthalate)* **IS USED IN** . . . . . microwavable food trays; salad dressing, soft drink, water, and beer bottles **STATUS** . . . . . hard to clean; absorbs bacteria and flavors; avoid reusing **IS RECYCLED TO MAKE** . . carpet, furniture, new containers, Polar fleece
	**Number 2** • *HDPE (high-density polyethylene)* **IS USED IN** . . . . . household cleaner and shampoo bottles, milk jugs, yogurt tubs **STATUS** . . . . . transmits no known chemicals into food **IS RECYCLED TO MAKE** . . detergent bottles, fencing, floor tiles, pens
	**Number 3** • *V or PVC (vinyl)* **IS USED IN** . . . . . cooking oil bottles, clear food packaging, mouthwash bottles **STATUS** . . . . . is believed to contain phalates that interfere with hormonal development; avoid **IS RECYCLED TO MAKE** . . cables, mudflaps, paneling, roadway gutters

Recyclable home plastics

Number 4 • *LDPE (low-density polyethylene)*

IS USED IN . . . . . bread and shopping bags, carpet, clothing, furniture
STATUS . . . . . transmits no known chemicals into food
IS RECYCLED TO MAKE . . envelopes, floor tiles, lumber, trash-can liners

Number 5 • *PP (polypropylene)*

IS USED IN . . . . . ketchup bottles, medicine and syrup bottles, drinking straws
STATUS . . . . . transmits no known chemicals into food
IS RECYCLED TO MAKE . . battery cables, brooms, ice scrapers, rakes

Number 6 • *PS (polystyrene)*

IS USED IN . . . . . disposable cups and plates, egg cartons, take-out containers
STATUS . . . . . is believed to leach styrene, a possible human carcinogen, into food; avoid
IS RECYCLED TO MAKE . . foam packaging, insulation, light switchplates, rulers

Number 7 • *Other (miscellaneous)*

IS USED IN . . . . . 3- and 5-gallon water jugs, nylon, some food containers
STATUS . . . . . contains bisphenol A, which has been linked to heart disease and obesity; avoid
IS RECYCLED TO MAKE . . custom-made products

Plastics…….Science

- Plastics are , synthetics made from OIL , natural gas, wood fibers ,corn and banana peel .
- The essential ingredient being C and H .
- O, N, Cl, S lend variety to plastics
- Plastics are synthetically generated through polymerization of mainly ethylene C 2H2, derived from cracking lighter fractions and naphtha.
- Polymerization is often started by combining the monomers through the use of a *catalyst* -.

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- Millions of polymer chains, called resins are formed at the same time.
- Polyethylene resins ,differing in density and weight are sold to plastics factories, as powder, tiny granules, or pellets.
- Additives modify the properties of the material, besides heating melting and shaping for the intended product

Classifications

- Plastics are classified into two categories
- *Thermoplastics* : Melt when heated, then harden again when cooled.
- *Thermosets,* , on high heat ,cracks or char, ideal for high-heat applications such as electronics and appliances, E -wastage
- 80% of the plastics produced are thermo- plastics ie polyethylene, Polypropylene, Polystyrene and Poly Vinylchoride (PVC)
- IIT Madras finds eco –friendly way to degrade polyethlyne and some other thermoplastics.

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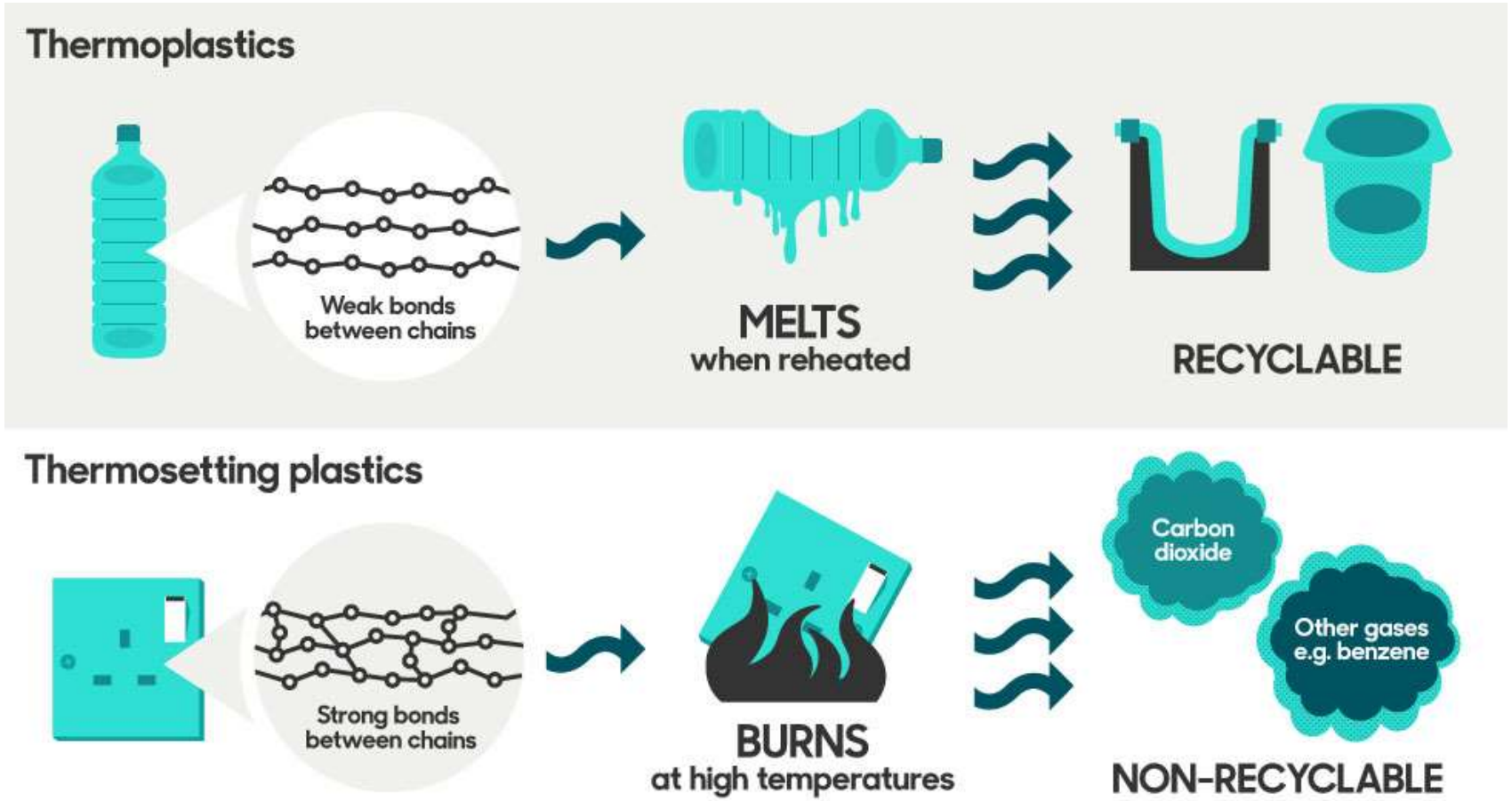

Thermoplastics
Weak bonds between chains
MELTS when reheated
RECYCLABLE
Thermosetting plastics
Strong bonds between chains
BURNS at high temperatures
Carbon dioxide
Other gases e.g. benzene
NON-RECYCLABLE

Thermoplast Plastic

- Thermo- plast granules or resins are moulded under high temperature and pressure.
- After cooling the mould is opened and plastic is formed.
- Thermoplastics have long, linear polymer chains that are only weakly chemically bonded, or connected, to each other.
- When a thermoplastic object is heated, these bonds are easily broken, explaining why they can readily be remoulded and reshaped into other products .They have low melting points.

Thermosets

- Thermosets are formed by curing linear polymers ,which involves high pressure ,temperature and catalyst .
- Thermoset plastics remain **in a** permanent solid state once hardened.
- Thermosets are hard to recycle, but today there are methods of crushing the objects into a fine powder form for use as fillers in reinforced thermosets.
- In thermosets , the linear chains are crosslinked - strongly chemically bonded.
- This prevents a thermoset plastic object from being melted and reformed.

Thermoplastic has covalent bonds between monomers and weak van der Waal interactions between monomer chains.	Thermosetting Plastic has strong cross-links and a 3D network of covalently bonded atoms. The stiffness of plastic increases with the number of cross-links in the structure.
It is synthesised by addition polymerization.	It is synthesised by condensation polymerization.
It is processed by injection moulding, extrusion process, blow moulding, thermoforming process, and rotational moulding.	It is processed by compression moulding, reaction injection moulding.
This is lower in molecular weight, compared to thermosetting plastic.	This is high in molecular weight.
This has a low melting point, low	This has high melting point, high tensile

Bioplastics

- **Bioplastics** are plastics derived from renewable biomass sources, such as vegetable fats and oils, corn starch, or microbiota.
- **Bioplastic** can be made from agricultural by-products and also from used plastic bottles and other containers using microorganisms.
- Bioplastics are biodegradable and microorganisms can break it into CO2 and H2O.
- The degradation rates of bioplastics were proportionate to the bacterial biomass in the soil.
- Since, a fertile soil is rich in bacterial biomass; bioplastics degrades in fertile soil environments.

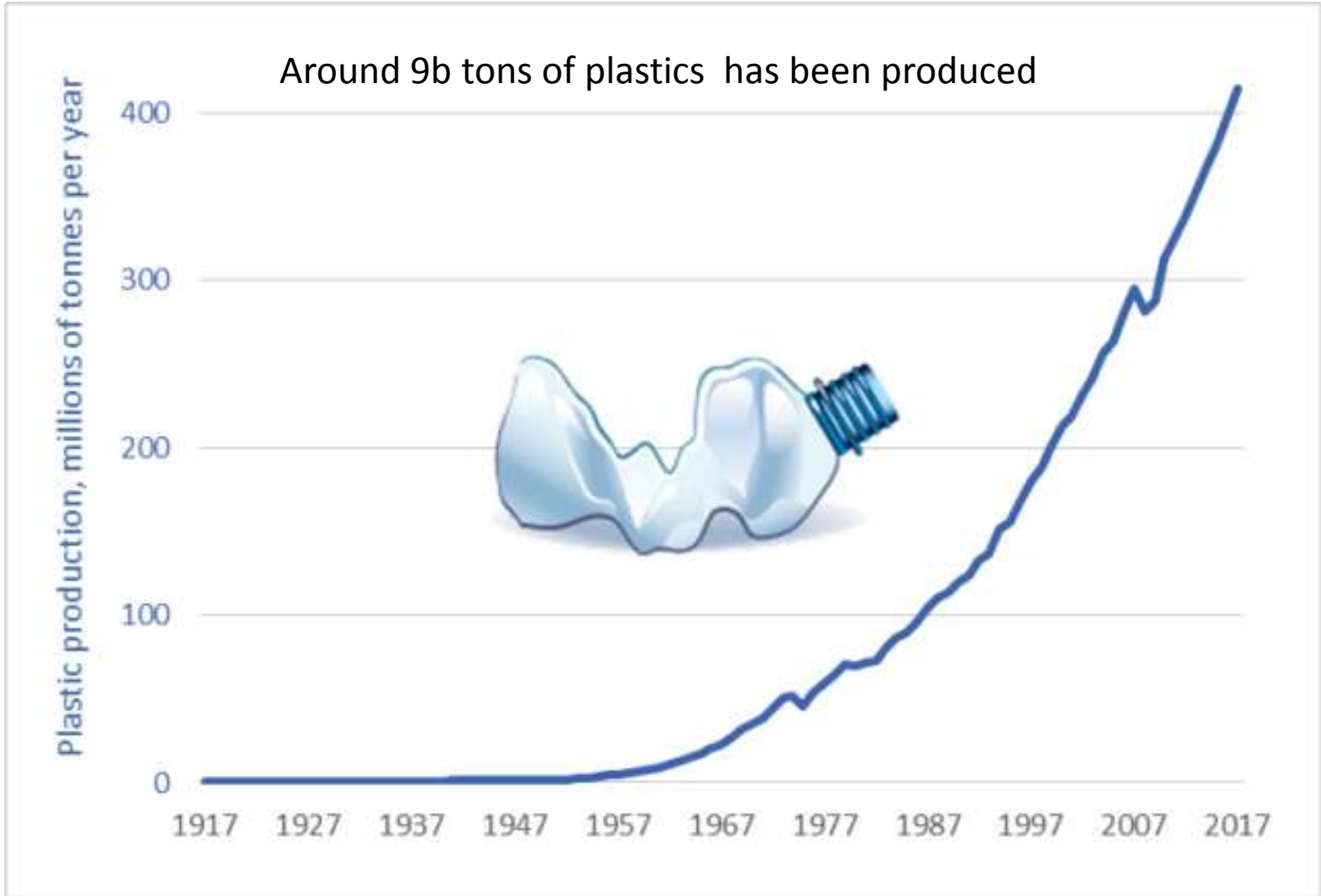
Types of Bio-plastics

- **Starch-based plastics** Thermoplastics starch currently represents the most widely used bioplastic, constituting about 50 percent of the bioplastics market used for production of drug capsules by the pharmaceutical sector.
- **Cellulose** bioplastics. Cellulose can become thermoplastic when extensively modified. An example of this is cellulose acetate
- **Protein based Bioplastics** from wheat gluten ,casein (plastic made from milk), soy protein is being considered as another source of bioplastic. Soy proteins have been used in plastic production for over one hundred years. For example, body panels of an original Ford automobile were made of soy-based plastic.
- There are many more.

Plastic Pollution

- Plastic pollution is the accumulation of plastic objects and particles in the Earth's environment that adversely affects wildlife habitat, and humans. Plastics that act as pollutants are categorized into micro-, meso-, or macro debris, based on size.

Around 9b tons of plastics has been produced



Plastic Pollution…. few facts

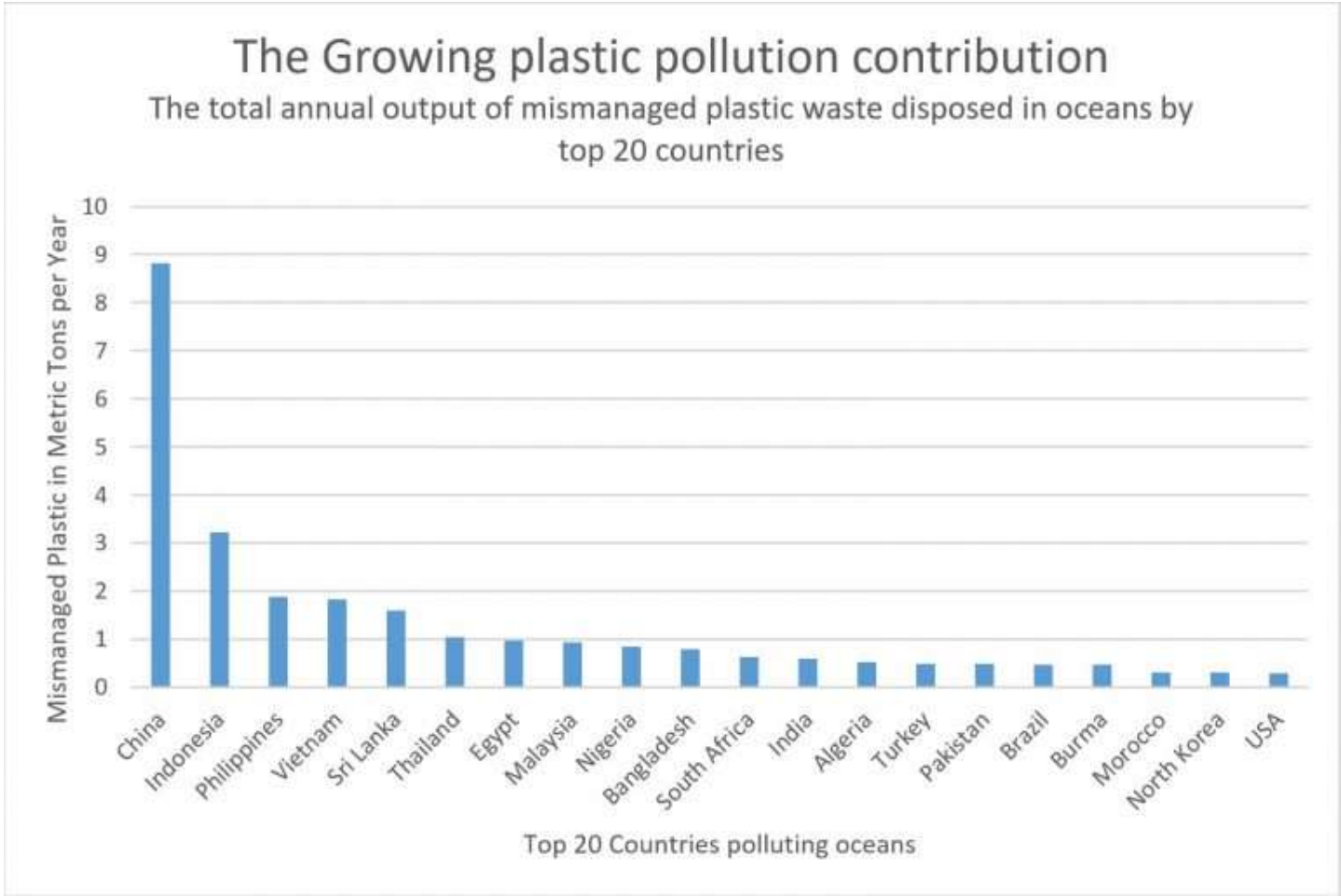
- Around 9 b tons of plastics has been produced …..
- Around 7 bn tons is now waste
- 79% of that is in landfill or the natural environment.
- 9.5m tons in 2015 ends up in sea .
- Seven of the EU Member States plus Norway and Switzerland recover more than 80% of their used plastics.
- These countries adopt an integrated waste and resource management strategy to address each waste stream with the best options.
- India generates 25000 t/d of plastic waste ,atleast 10000 t/d is non recycled .
- Single use plastics should necessarily be bio plasts.

Single Use Plastics

- The most common single-use plastics found are carry bags, plastic drinking bottles, plastic bottle caps, food wrappers, plastic grocery bags, plastic sachets, plastic wrappers for consumer goods, multi-layer packaging used for food packing.
- The European Union, for instance, describes 'single-use plastics' as plastics as products made of plastic such as cotton-bud sticks, cutlery, plates, straws, sticks for balloons, cups, food, beverage containers made of polystyrene and products made of oxo-degradable plastic, etc.
- Plastic below 50 microns with less than 20 per cent recycled content are single-use plastic as per Industry.

Ocean polluting countries

Deaths of over a million seabirds every year, over 100,000 marine mammals



Marine Pollution

- 95 percent of plastic polluting the world's oceans comes from just 10 rivers …..Dr Christian Schmidt
- Yangtze - East China Sea, Asia
  Indus - Arabian Sea, Asia
  Yellow - Yellow Sea, Asia
  Hai He - Yellow Sea, Asia
  Nile - Mediterranean Sea, Africa
  Ganges - Bay of Bengal, Asia
  Pearl - South China Sea, Asia
  Amur - Sea of Okhotsk, Asia
  Niger - Gulf of Guinea, Africa
  Mekong - South China Sea, Asia

THANK YOU