SOLID WASTE MANAGEMENT

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1. Introduction:

Waste:

Depending on their physical state they are classified as:

- Liquid wastes
- Gaseous wastes
- Solid wastes.

Solid waste: Solid waste is the unwanted or useless solid materials generated from combined residential, industrial and commercial activities in a given area.

[Ref: T. Srinivas, Environmental Biotechnology, www.cyen.org]

Solid Waste Management:

Solid waste management is the process of collection, transportation and disposal of solid waste in a systematic, economic and hygienic manner.

‘Or’

Solid-waste management is the process of the collecting, treating, and disposing of solid material that is discarded because it is of no longer use.

[Ref**:** T. Srinivas, Environmental Biotechnology, www.britannica.org]

2. Classification of Solid Waste:

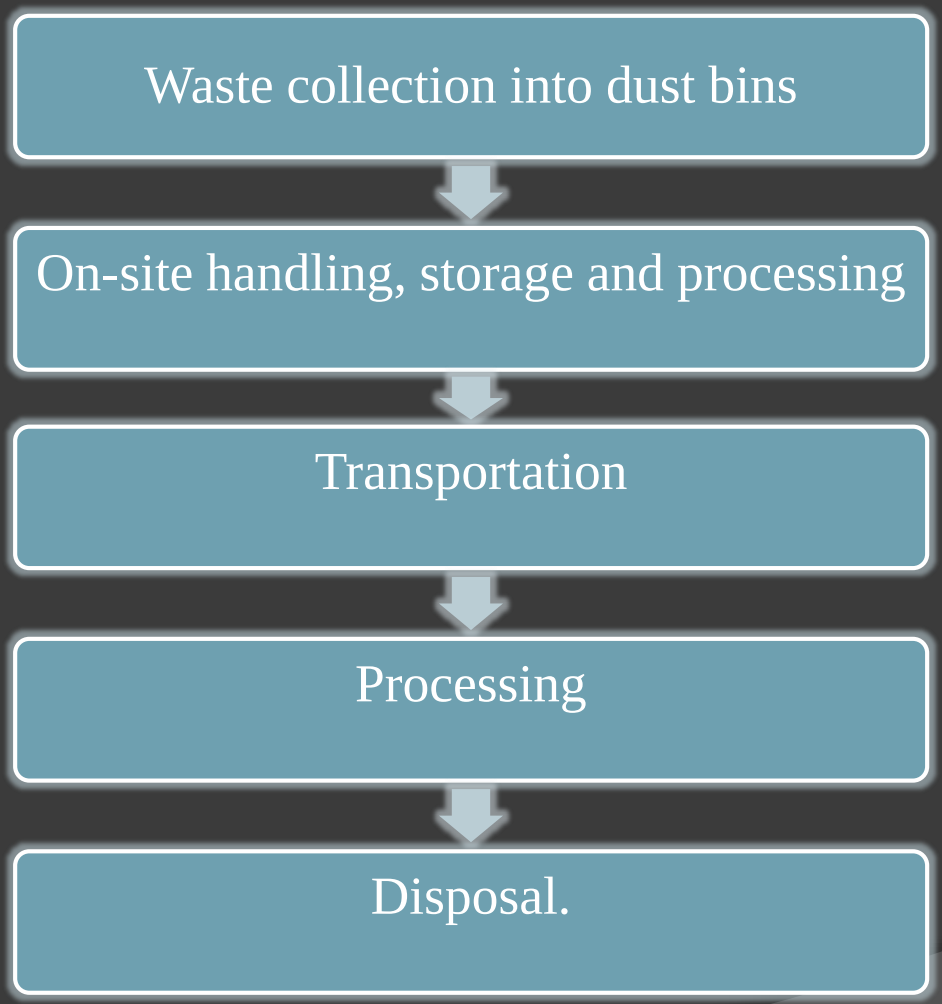
Solid wastes are classified as:

- ✓ Based on their sources of origin:
  - ❑ Residential wastes
  - ❑ Commercial wastes
  - ❑ Institutional waste
  - ❑ Municipal wastes
  - ❑ Industrial wastes
  - ❑ Agricultural wastes
- ✓ Based on physical nature:
  - ❑ Garbage
  - ❑ Ashes
  - ❑ Combustible and non-combustible wastes
  - ❑ Demolition and construction wastes
  - ❑ Hazardous wastes

S. No.	Type	Description	Sources
1.	Garbage (Biodegradable food wastes)	Residual vegetable or animal wastes resulting from the handling, preparation, cooking and eating of foods. They are putrescible, and decompose rapidly, especially in warm weather.	Houses, Hotels, Dairies, Meat stalls etc.
2.	Combustible and non-combustible solid waste	Combustible solid wastes, as paper, cardboard, plastics, textile, rubber, leather, wood, furniture and garden trimmings. Non-combustible solid wastes as glass, crockery, tin cans, ferrous and non ferrous metals.	Households, Offices, Hotels, Markets etc.

3.	Ashes	Residues remaining after the burning of wood, coal, coke and other combustible wastes.	Fire places and Kitchens of houses, hotels, hostels etc.
4.	Demolition and construction wastes	Inert wastes such as dirt, stones, concrete, bricks, pieces of plumbing and heating and electrical parts	Demolition and Construction of buildings
5.	Industrial wastes	They are specific for a specific industry. Their characteristics vary widely as inert, highly biodegradable, toxic, reactive, odorous, corrosive, hot, cold, coloured, viscous, inflammable and dusty	Different types of Industries, Thermal power plants etc.

3. Engineered systems for solid waste management:



[Ref: T. Srinivas, Environmental Biotechnology]

4. Methods for the treatment of the solid waste:

With different types of wastes, different treatment methods are applied. These treatment processes has been listed below:

- Open Dumps
- Landfills
- AnaerobicDigestion
- Composting
- Vermicomposting
- Encapsulation
- Incineration

i. Open Dumps:

- Open dumps refer to uncovered areas that are used to dump solid waste of all kinds.
- The waste is untreated, and not segregated.
- It is the breeding ground for files, rats, and other insects that spread disease.
- The rainwater run-off from these dumps contaminates nearby land and water, thereby spreading disease. In some countries, open dumps are being phased out.

Open dump site

[Ref: Indu Shekhar Thakur- Environmental Biotechnology]

ii. Landfills:

•A landfill may also refer to the ground that has been filled in with soil and rocks instead of waste materials, so that it can be used for a specific purpose, such as for building houses.

•Landfill, also known as a dump or tip, is a site for disposal of waste materials by burial.

•Older, poorly designed or poorly managed landfills can create a number of adverse environmental impacts such as wind-blown litter, attraction of vermin, and generation of liquid leachate.

[Ref: Indu Shekhar Thakur- Environmental Biotechnology, T. Srinivas, Environmental Biotechnology]

➢ Sanitary landfills:

•Sanitary Landfills are designed to greatly reduce or eliminate the risks that waste disposal may pose to the public health and environmental quality.

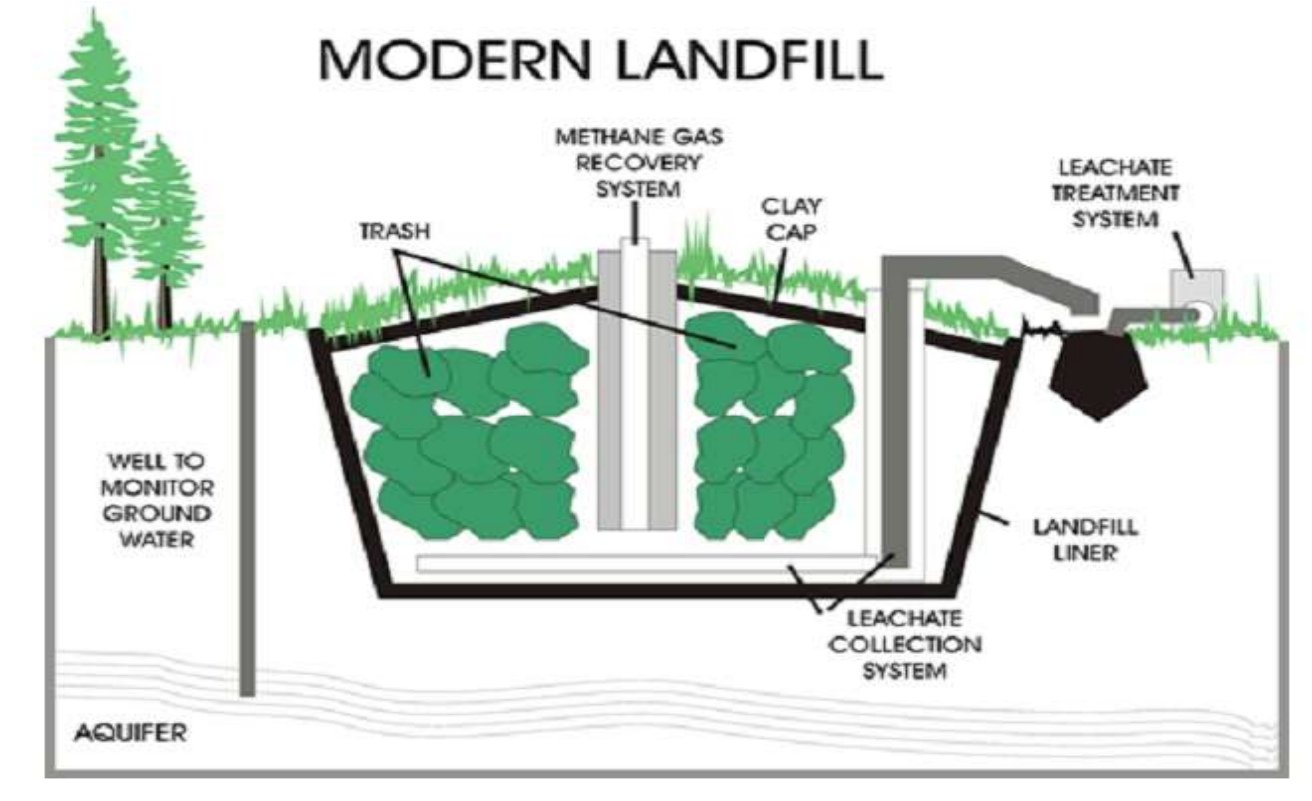


Fig: Main features of a modern landfill (Sanitary landfill)

[Ref: Indu Shekhar Thakur- Environmental Biotechnology and www.cyen.org]

iii. Composting:

Composting is the biological decomposition of organic waste under controlled aerobic condition.

Industries as paper, agricultural and food processing give out wastes which are almost 100% organic. This organic matter can be composted to yield good manure.

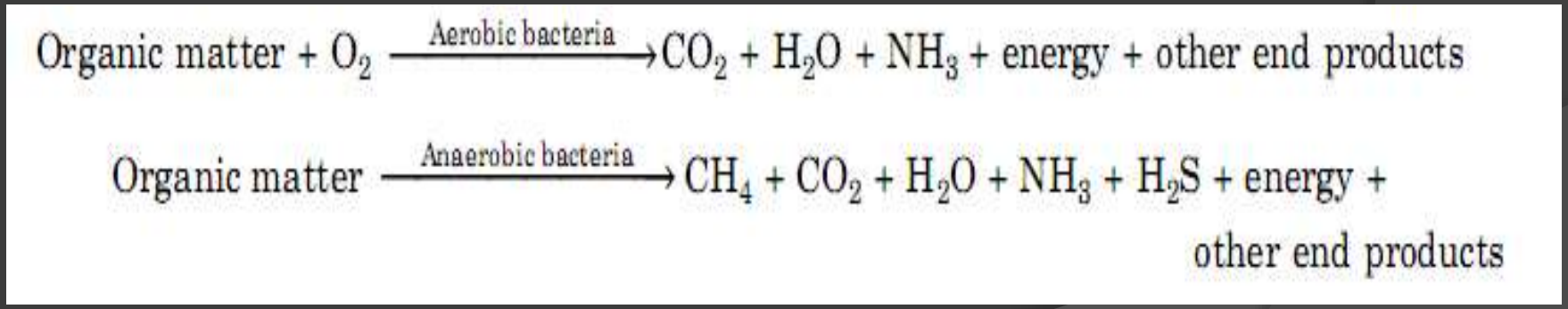
Compost is the end product obtained after subjecting the organic fraction of solid waste to aerobic or anaerobic decomposition to yield humus like solid, carbon dioxide, water vapour and energy.

Fig: Compost cycle

[Ref: Indu Shekhar Thakur- Environmental Biotechnology and www.cuesa.org]

➢ Different stages of composting:

- ❑ Segregation of solid waste
- ❑ Processing the compostable matter
- ❑ Preparation for compost
- ❑ Digestion
- ❑ Curing
- ❑ Screening



[Ref: T. Srinivas, Environmental Biotechnology]

➢ Mechanism of composting:

• Composting is a very complex process involving the participation of several microorganisms like bacteria, actinomycetes and fungi.

• The bacteria bring out the decomposition of macromolecule namely proteins and lipids. Besides generating energy (heat) . Fungi and actinomycetes degrade cellulose and other complex organic compounds.

• Composting may be divided into three stages with reference to changes in temperature**:**

- ❑ Mesophilic stage
- ❑ Thermophilic stage
- ❑ Cooling stage

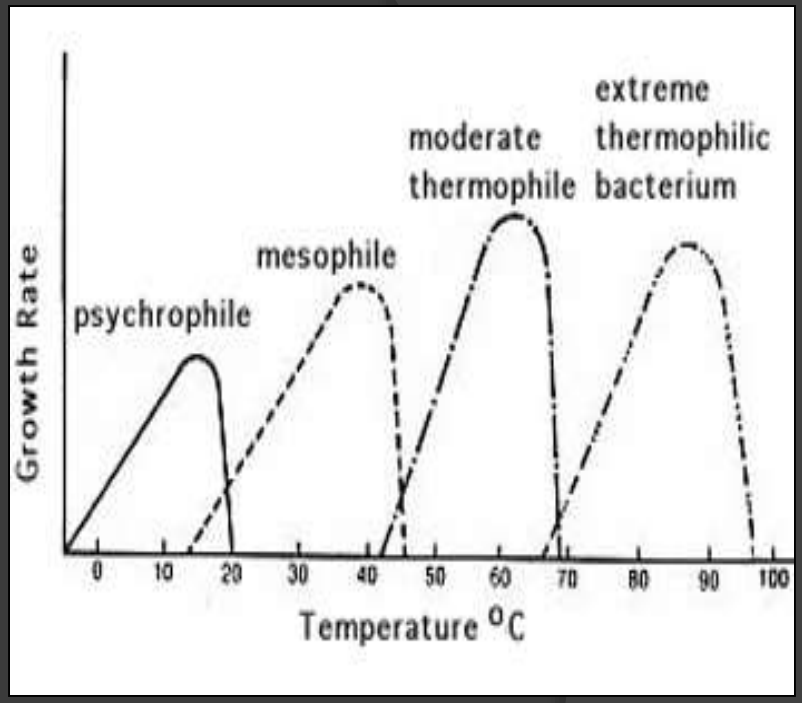


Fig**:** Growth pattern of microbes during composting

[Ref**:** U.Satayanarayan, Biotechnology, and S.V.S Rana, environmental Biotechnology]

iv. Anaerobic Digestion:

• Anaerobic digestion is a regulated version of the natural events of landfill, in that it results in the controlled release of methane-rich biogas, which offers the potential for a very real form of energy from waste.

• It is carried out in large fermented tanks.

• In these tanks, solid waste is taken in the absence of oxygen and the anaerobic bacteria convert the large organic molecules mainly into methane CH_4 and carbon dioxide CO_2.

• Unlike composting, Anaerobic Digestion occurs at one of three distinct temperature ranges, namely:

- ❑ Cryophilic (<20 °C)
- ❑ Mesophilic (20–45 °C)
- ❑ Thermophilic (>45 °C)

[Ref: Gareth M. Evans, Environmental Biotechnology, Theory and Application]

➢ Micro-organisms involved in Anaerobic digestion:

There are four main groups of bacteria involved in Anaerobic digestion, as shown below, with some typical examples of each**:**

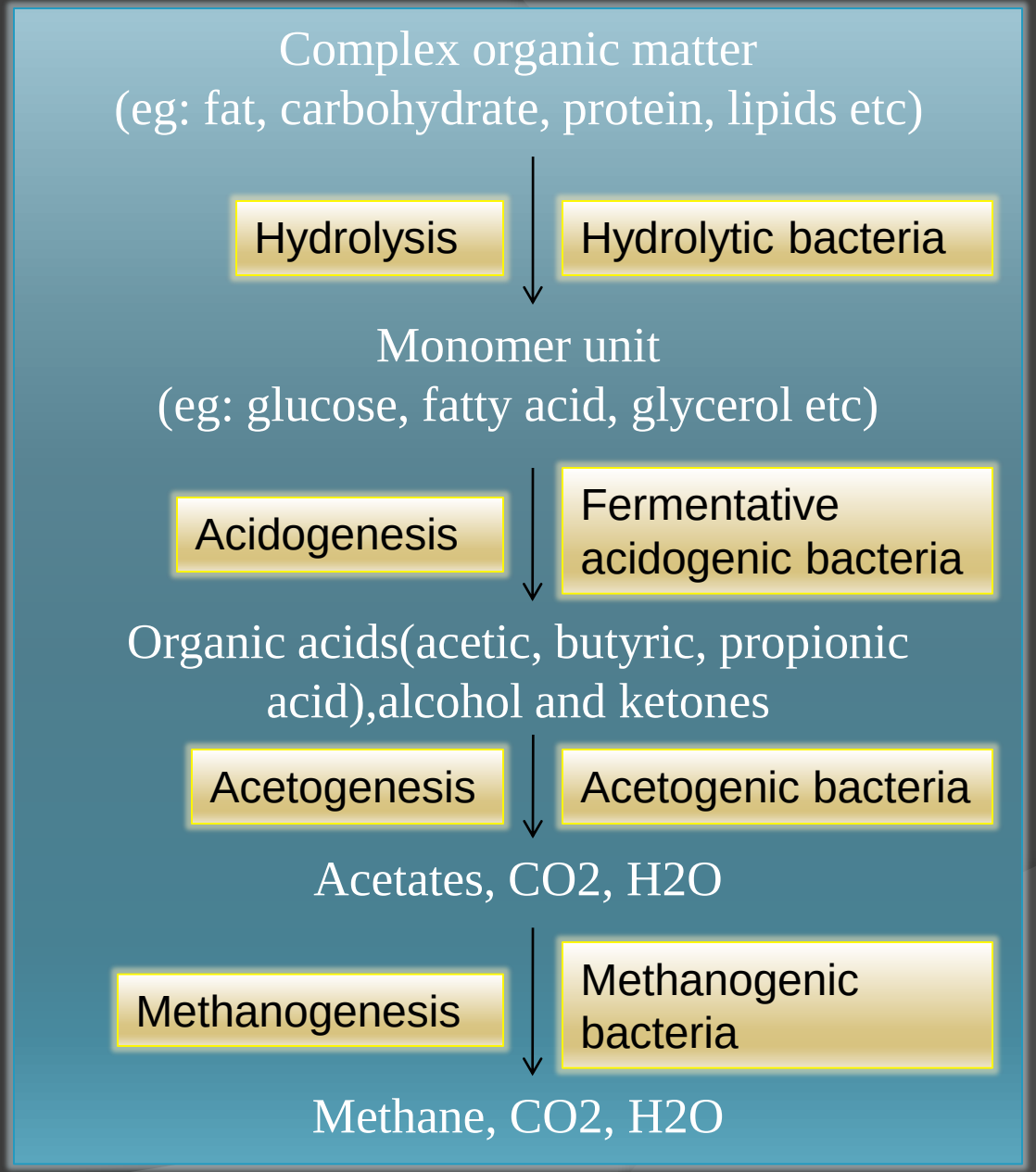
- **Hydrolytic fermentative bacteria** – *Clostridium and Peptococcus*.
- **Acetogenic bacteria** – *Syntrophobacter and Syntrophomonas.*
- **Acidogenic bacteria** – *Methanosarcina and Methanothrix.*
- **Methanogenic bacteria** – *Methanobacterium and Methanobrevibac*terium.

[Ref: Gareth M. Evans, Environmental Biotechnology, Theory and Application]

➢ The digestion process:

The digestion process involves 4 steps. They are:

- ❑ Hydrolysis
- ❑ Acidogenesis
- ❑ Acetogenesis
- ❑ Methanogenesis



[Ref: Gareth M. Evans, Environmental Biotechnology, Theory and Application]

v. Vermicomposting:

• Vermicomposting is a simple biotechnological process of composting, in which certain species of earthworms are used to enhance the process of waste conversion and produce a better end product.

• Vermicomposting differs from composting in several ways.

- ❑ Utilizing microorganism's (earthworms that are active at 10–32°C).
- ❑ The process is faster than composting (Because the material passes through the earthworm gut, a significant but not yet fully understood transformation takes place, whereby the resulting earthworm castings (worm manure) are rich in microbial activity and plant growth regulators).

[Ref: Indu Shekhar Thakur- Environmental Biotechnology]

➢ Types of earthworms:

There are nearly 3600 types of earthworms in the world and they are mainly divided into two types**:**

- ❑ **Burrowing earthworm**
- ❑ **Non-burrowing earthworm.**

The Indian Species are: *Dichogaster bolaui*, *Drawida willsi*, *Lampito mauritti*, *perionyx excavates*, *O.Surensis*, *M.elongata.*

Characters	Burrowing earthworm	Non-burrowing earthworm
Habitat	Live deep in soil.	Live in upper layer of soil
Colour	Pale	Red, Purple
Length	20-30 cm.	10-15 cm.
Life span	15 years	28 months
Example	*Pertima elongate*, *Pertima asiatica*	*Eisenia fetida*, *Eudrilus eugenae*

➢ Vermicomposting process:

Vermicomposting Process

[Ref: www.icrisat.org]

❑ Encapsulation:

Solid particulate waste material is coated with a thermosetting resin which is compressed and cured to form a rigid core. The rigid core is coated with a flexible thermoplastic resin to provide a sealed encapsulated waste agglomerate which can withstand moderate compressive loads.

Encapsulation method are of the types:

- ❑ **Microencapsulation**
- ❑ **Microencapsulation**

[Ref**:** Indu Shekhar Thakur- Environmental Biotechnology, www.google.com/patents/US4234632]

❑ Incineration:

•Incineration is the most common thermal treatment process. It is burning of the waste at a temperature of 1000°C ± 100°C in the presence of oxygen so as to eliminate all odours and to ensure good combustion.

•After incineration, the wastes are converted to carbon dioxide, water vapour and ash.

•It converts hazardous organic substances into less hazardous components.

4. Management of Solid waste:

The fundamental objective of waste processing is to reduce the amount of wastes through recycling and disposal of waste in a way not to impair environmental conservation.

Four R's should be followed for waste management**:**

- **Refuse**
- **Reuse**
- **Recycle**
- **Reduce**

[Ref**:** Indu Shekhar Thakur- Environmental Biotechnology]

The management of the solid waste is done according to its nature:

i. Management of Medical solid waste
ii. Management of non-degradable solid waste
iii. Management of Hazardous waste
iv. Management of non-hazardous & biodegradable solid waste
v. Management of electronic waste “e-waste”

[Ref: Indu Shekhar Thakur- Environmental Biotechnology]

i. Management of Medical solid waste:

• Hospital waste is generated during the diagnosis, treatment, or immunization of human beings or animals or in research activities in these fields or in the production or testing of biological.

• Medical solid waste includes both non-hazardous and hazardous waste constituents.

- ✓ The non-hazardous waste
- ✓ Hazardous wastes

Medical solid waste

Treatment options:

- ❑ **Incineration**
- ❑ **Sanitary landfill**

[Ref: Indu Shekhar Thakur- Environmental Biotechnology]

ii. Management of non-degradable solid waste:

- Examples of non-degradable solid wastes are:
  - Ferrous & non-ferrous metals: Eg: Iron, Steel and Aluminium etc.
  - Glass
  - Plastics
  - Textiles

- **Treatment options:**
  - Recycling
  - Sanitary landfill
  - Incineration

[Ref: Indu Shekhar Thakur- Environmental Biotechnology]

iii. Management of Hazardous waste:

Following process applied in hazardous waste treatment:

- **Physical separation**
- **Gravity separation**
- **Dissolved air floatation**
- **Solvent extraction**
- **Sorption on activated carbon**

Treatment options:

- Thermal treatment
  - Incineration
- Biological treatment

Hazardous waste

[Ref: Indu Shekhar Thakur- Environmental Biotechnology]

iv. Management of non-hazardous & biodegradable solid waste:

•Non-hazardous solid waste is total waste including municipal waste, industrial waste, agricultural waste and sewage sludge.

•Following methods are followed by management of non-hazardous and biodegradable solid wastes:

- Open Dumps
- Landfills
- Anaerobic Digestion
- Composting
- Vermicomposting

[Ref: Indu Shekhar Thakur- Environmental Biotechnology, T. Srinivas, Environmental Biotechnology]

vi. Management of Electronic waste, “E-Waste”:

- Electronic waste is of concern largely due to the toxicity and carcinogenicity of some of the substances if processed improperly. Toxic substances in electronic waste include lead, mercury and cadmium. Carcinogenic substances in electronic waste may include polychlorinated biphenyls (PCBs).

- A typical computer may contain more than 6% lead by weight. Capacitors, transformers, PVC insulated wires of polychlorinated biphenyls.

[Ref**:** Indu Shekhar Thakur- Environmental Biotechnology]

➢ Sources, Constituents and effect of E-waste:

Source of e-wastes	Constituent	Health effects
Solder in printed circuit boards, glass panels and gaskets in computer monitors	Lead (PB)	• Damage to central and peripheral nervous systems, blood systems and kidney damage. • Affects brain development of children.
Chip resistors and semiconductors	Cadmium (CD)	• Toxic irreversible effects on human health. • Accumulates in kidney and liver.
Relays and switches, printed circuit boards	Mercury (Hg)	• Chronic damage to the brain. • Respiratory and skin disorders due to bioaccumulation in fishes.
Corrosion protection of untreated and galvanized steel plates, decorator or hardner for steel housings	Hexavalent chromium (Cr) VI	• Asthmatic bronchitis. • DNA damage.

➢ Treatment options:

E-waste consists of Diverse items like ferrous and non-ferrous metals, glass, plastics, electronic components and other items. The potential treatment options based on this composition are given below:

- ❑ Encapsulation
- ❑ Incineration
- ❑ Sanitary landfill

[Ref**:** T. Srinivas, Environmental Biotechnology]

Reuse of the electronic waste in the form of a stool:

Designer **Rodrigo Alonso** created **N+ew Seats** to address this -- stools that are formed of a whole lot of electronic junk. This was covered back in 2007.

The idea behind N+EW isn’t the creation of a recyclable object, but the way to immortalize and to give a last use to objects that their only destination is contamination."

E-Waste Furniture

[Ref: www.treehugger.com]

5. Factors affecting solid waste management:

There are certain factors that affect the management of solid waste: management. They are:

- **Per capita income and status**
- **Climate and percentage moisture**
- **Systematic growth of city**
- **Status of the municipality**
- **Resources available**

[Ref: T. Srinivas, Environmental Biotechnology]

6. Conclusion:

Solid waste management is the process of removal of solid waste in such a manner that it does not cause any problem to environment and the living organism as well. It is done through different methods as per the category of the solid waste.