Atomic Material and Radiation Sterilization are concepts of the Science and Technology section of the UPSC exam.

Facts about Radiation Sterilization

- Radiation Sterilization is a **cold process** that uses gamma radiation for sterilization of Healthcare Products.
- Controlled gamma energy which is released by radioisotopes such as Cobalt-60 is used for sterilization.
- Cobalt-60 is the most **preferred radioisotope as it is readily available** from a single nuclear reaction in a reactor and also cost effective.
- Gamma radiation is characterized by deep penetration and kills microorganisms by destroying DNA structure.
- The process is suitable for Industrial scale sterilization.
- Radiation dose of 25 kGy (2.5 Mrad) is officially accepted for sterilization of healthcare products.
- Delivery of dose to the products is measured by dosimeter. Radiation sterilized products are acceptable by the Food & Drug Administration (FDA).

Advantages and Benefits of Radiation Sterilization

(a) **Products of any shape can be sterilized:** A product of any form and shape can be sterilized as the gamma rays are powerful enough to penetrate a high density package and the product itself.

(b) **Heat-sensitive materials can be sterilized:** As it is a cold process with no known sources of heat, more-sensitive products such as medical devices and pharmaceutical products can be safely sterilized.

(c) **Flexibility in packaging:** Radiation sterilization causes no long term physical changes to the products as they can be packed individually in sealed bags and sterilized in the fully packaged form.

(d) **Retention of product sterility:** Since sterilization is effected after final packaging, product sterility is retained indefinitely provided the package is undamaged.

(e) **Pre-packaged products:** Radiation Sterilization enlarges the market for ready to use pre-packaged products. The process does not result in residual toxicity of any form in the product.

(f) **Safe to use:** Products sterilized by this process do not become radioactive and are safe for use.

Note: A Gamma Radiation Processing Facility **is licensed by** Atomic Energy Regulatory Board (AERB) and Local Food & Drug Administration (FDA).

- High energy Electron Beam (EB) and X-ray machines are also used nowadays for this purpose.
- The **major difference** in gamma radiation and EB lies in their penetration powers, where gamma radiations can penetrate deep inside the products the electron beams do not have as good penetration power.
- Though X-ray have comparable penetration power to gamma radiation at suitable energy range but they are not yet very popular.
- The Board of Radiation and Isotope Technology (BRIT)/Department of Atomic Energy (DAE) had set up a **radiation sterilization plant** '**ISOMED**' which has been in operation since 1974 for sterilization of medical products.
- Technology has been found to be effective, reliable and acceptable among users.

Note: This concept has high potential to be asked in the UPSC Preliminary examination. Aspirants should make a note of it and include the same in their revision.

Questions related to Atomic Materials and Radiation Sterilization

How is gamma radiation used in sterilization?

Gamma irradiation is a physical/chemical means of sterilization, because it kills bacteria by breaking down bacterial DNA, inhibiting bacterial division. Energy of gamma rays passes through the equipment, disrupting the pathogens that cause contamination.

How is cobalt 60 used in sterilization?

The gamma sterilization process uses Cobalt 60 radiation to kill microorganisms on a variety of different products. Processing with gamma irradiation yields quick turnaround time, easily penetrating packaging and product, and is ideal for many types of materials.

What food products are sterilized by using radiation?

The following food products are sterilized

- Beef and Pork.
- Crustaceans (e.g., lobster, shrimp, and crab)
- Fresh Fruits and Vegetables.
- Lettuce and Spinach.
- Poultry.

• Seeds for Sprouting

How gamma rays are used?

Gamma rays are ionizing electromagnetic radiation, obtained by the slow wasting of an atomic nucleus. Gamma rays are more penetrating, when it comes to raw matter thus they can cause heavy damage to living cells. Gamma rays are used in medicine (radiotherapy), industry (sterilization and disinfection) and the nuclear industry.

What objects emit gamma rays?

Gamma rays have the smallest wavelengths and the most energy of any wave in the electromagnetic spectrum. They are produced by the hottest and most energetic objects in the universe, such as neutron stars and pulsars, supernova explosions, and regions around black holes.