Microplastics

For Prelims: Microplastics, Polyethylene, Solar UV radiation, Global Plastic Overshoot Day (POD), Ashtamudi Lake, Ramsar wetland, United Nations Environment Assembly (UNEA), Intergovernmental Negotiating Committee (INC), United Nations Environment Programme (UNEP) Plastics Treaty, Commonwealth Clean Oceans Alliance, New Zealand's Waste Minimization (Microbeads) Regulations, Plastic Waste Management Rules, 2016, Plastic Waste Management (Amendment) Rules, 2024.

For Mains: Ban on Single-Use Plastics, Microplastics and Environmental challenges, Health challenges, Regulatory and policy challenges, Detection and analysis challenges, Public awareness and education.

Source: DTE

Why in News?

Recently, a study revealed the widespread occurrence of microplastics **in the testicles of both humans and canines**, potentially associated with **decreased sperm count,** with polyethene emerging as the predominant microplastic followed by PVC.

What are Microplastics?

- **About:**
  - They are defined as **plastics less than five millimetres** in diameter. It can be harmful to our ocean and aquatic life.
  - Under the influence of **solar UV radiation**, wind, currents, and other natural factors, plastic fragments into small particles, termed microplastics (particles smaller than 5 mm) or nanoplastics (particles smaller than 100 nm).
- **Classification:**
  - **Primary Microplastics:** They are tiny particles designed for **commercial use** and microfibers shed from clothing and other textiles.
    - E.g., microbeads found in personal care products, plastic pellets, and plastic fibres.
  - **Secondary Microplastics:** They are formed from the **breakdown of larger plastics,** such as water bottles.
    - Exposure to environmental factors, primarily solar radiation and ocean waves, is the cause of this breakdown.
- **Applications of Microplastics:**
  - **Medical and Pharmaceutical Uses:** Used in **targeted drug delivery** due to the capacity to absorb and release chemicals effectively.
  - **Industrial Applications**: Used in **air-blasting technology** for cleaning machinery and in the production of synthetic textiles.
  - **Cosmetics and Personal Care Products:** Used as **exfoliating agents** in facial scrubs, toothpaste, and other personal care products.

What are the Current Developments Regarding Microplastics?

- **Microplastics in Testicular Tissues**: The study reported mean total microplastic levels of 122.63 µg/g in dogs and 328.44 µg/g in humans, with polyethene (PE) being the dominant polymer. This discovery raises concerns about the potential impact on human reproductive health, including **declining sperm counts.**
- **Global Plastic Overshoot Day (POD):** In 2024, POD is projected to occur on 5th September, marking the point when plastic waste generation exceeds the world's capacity to manage it.
    - By **the end of 2024, 217 countries are expected to release over 3 million tonnes of microplastics into waterways**, with China and India being the top contributors.
- **Microplastics in Drinking Water:** A critical review assessed the quality of 50 studies on microplastics in drinking water and freshwater sources.
    - It highlighted the **need for standardised sampling** and analysis methods, as **only four studies met all the quality criteria.**
- **Microplastic contamination in Ashtamudi Lake**: A study highlights significant microplastic pollution in **Ashtamudi Lake, a** Ramsar wetland, revealing microplastics in fish, shellfish, sediment, and water.
    - Hazardous heavy metals like molybdenum, iron, and barium were found in microplastics, posing risks to aquatic organisms and humans who consume contaminated fish and shellfish.

Regulations Related to Microplastics

- **Global:**
    - **United Nations Environment Assembly (UNEA) Resolutions:**
        - The UNEA resolution mandated the development of an **international legally binding instrument** on plastic pollution, including in the marine environment.
        - The resolution led to the establishment of the **Intergovernmental Negotiating Committee (INC)** to draft the treaty, to complete negotiations by the end of 2024
    - United Nations Environment Programme (UNEP) Plastics Treaty:
        - The UNEP is working on an international legally binding instrument to address plastic pollution, including microplastics.
    - **New Zealand's Waste Minimisation (Microbeads) Regulations**: New Zealand has **banned** the sale and manufacture of wash-off products containing plastic microbeads since 2017.
- **India:**
    - Ban on Single-Use Plastics
    - India Plastics Pact
    - Plastic Waste Management Rules, 2016
    - Plastic Waste Management (Amendment) Rules 2018
    - Plastic Waste Management (Amendment) Rules, 2024

What are the Challenges Related to Microplastics?

- **Environmental Challenges:**
    - Microplastics are highly persistent in the environment, and their small size allows them to be **transported over long distances,** making them ubiquitous pollutants.
    - Microplastics pose a **threat to wildlife,** especially marine organisms, as their ingestion can result in the bioaccumulation of toxic chemicals.
- **Health Challenges:**
    - Humans are exposed to microplastics through eating, breathing, and skin contact, which are found in tissues like the placenta and can cause health issues like oxidative stress, DNA damage, organ dysfunction, metabolic disorders, etc.
- **Regulatory and Policy Challenges**
    - Despite some countries banning microbeads, there's **no worldwide regulation** for all microplastic sources and inconsistent monitoring hampers pollution mitigation efforts.
    - Limited resources, inadequate infrastructure, and lack of public awareness impede the effective enforcement of existing regulations.

- **Detection and Analysis Challenges:** Detecting and quantifying microplastics in environmental samples is challenging **due to their diverse properties.**

Way Forward

- **Scientific Research and Monitoring:**
  - Developing and promoting the use of biodegradable plastics can help reduce the persistence of microplastics in the environment.
  - Filtration systems in wastewater treatment plants and devices to capture microplastics from stormwater runoff can help reduce microplastics entering aquatic environments.
    - Techniques such as Fourier-transform infrared spectroscopy (FTIR), Raman spectroscopy, and mass spectrometry are commonly used but need further refinement to improve accuracy and reliability.
- **Regulatory Measures:**
  - Implementing bans on single-use plastics and microbeads in personal care products can significantly reduce the release of primary microplastics into the environment.
    - The **European Union's REACH regulation** is an example of such a measure.
  - EPR schemes make producers responsible for the entire lifecycle of their products. This can incentivise manufacturers to design more sustainable products and reduce plastic waste.
- **Innovative Ways to Deal with Microplastics:**
  - **Biodegradable Silk**: Researchers at MIT have developed a **silk-based system** that can replace microplastics in various applications, including agricultural products, paints, and cosmetics.
  - **Plant-Based Filters**: The **filter made of tannins** and wood dust that can trap up to 99.9% of microplastics in water.
  - **Natural Fiber Textiles**: Natural fiber textiles do not release microplastics during washing and are biodegradable under the right conditions. These materials offer a sustainable alternative to synthetic fibers like polyester and nylon.
- **Public Awareness and Education:**
  - Incorporating information about microplastics and their **impacts into school curricula** can educate the next generation about the importance of reducing plastic pollution and adopting sustainable practices.

Drishti Mains Question:

Q. Discuss the challenges posed by microplastics to human health. Suggest measures to mitigate these risks.

UPSC Civil Services Examination, Previous Year Question (PYQ)

Mains

Q. How can the mountain ecosystem be restored from the negative impact of development initiatives and tourism? **(2019)**

Q. What are the impediments in disposing the huge quantities of discarded solid waste which are continuously being generated? How do we remove safely the toxic wastes that have been accumulating in our habitable environment? **(2018)**