Nobel Prize for Chemistry, 2021

Why in News

The **2021** Nobel Prize **in Chemistry** was awarded to **Benjamin List and David MacMillan** for the development of **asymmetric organocatalysis.**

- **Last year,** the honour went to **Frenchwoman Emmanuelle Charpentier and American Jennifer Doudna**, for developing the gene-editing technique known as **CRISPR-Cas9** - **DNA snipping "scissors".**
- **Nobel prizes in** physics **and** medicine for 2021 have already been announced.

Key Points

- **About the Development:**
    - They have developed a **new and ingenious tool for molecule building: organocatalysis.**
        - Many research areas and industries are **dependent on chemists' ability to construct molecules** that can form elastic and durable materials, store energy in batteries or inhibit the progression of diseases. This **work requires catalysts.**
        - According to researchers, there were **just two types of catalysts available: metals and enzymes. Catalysts** are any substance that **increases the rate of a reaction** without itself being consumed.
    - In 2000, they, independent of each other, **developed a third type of catalysis.** It is called **asymmetric organocatalysis** and **builds upon small organic molecules.**
- **Significance:**
    - Its uses include **research into new pharmaceuticals** and it has also **helped make chemistry greener.**
    - Both these sets of **catalysts (metals and enzymes) had limitations.**
    - **Heavier metals are expensive**, difficult to mine, and toxic to humans and the environment.
        - Despite the best processes, **traces remained in the end product;** this posed problems in situations where compounds of very high purity were required, like in the manufacture of medicines.
        - Also, metals **required an environment free of water and oxygen**, which was difficult to ensure on an industrial scale.
    - **Enzymes** on the other hand, **work best when water is used** as a medium for the chemical reaction. But that is **not an environment suitable for all kinds of chemical reactions.**
- **Organocatalysis:**
    - Organic compounds are **mostly naturally-occurring substances**, built around a framework of carbon atoms and usually containing hydrogen, oxygen, nitrogen, sulphur, or phosphorus.

- **Life-supporting chemicals like proteins,** which are long chains of **amino acids** (carbon compounds containing nitrogen and oxygen) **are organic.**
- **Enzymes are also proteins**, and therefore, organic compounds. These are responsible for many essential biochemical reactions.
- **Organocatalysts allow several steps** in a production process to be performed in an unbroken sequence, considerably reducing waste in chemical manufacturing.
- Organocatalysis **has developed at an astounding speed since 2000**. Benjamin List and David MacMillan remain leaders in the field, and have shown that **organic catalysts can be used to drive multitudes of chemical reactions.**

    - Using these reactions, researchers can now more efficiently construct anything from new pharmaceuticals to molecules that can capture light in solar cells.

- **Asymmetric Organocatalysis:**

    - The process called asymmetric organocatalysis, has **made it much easier to produce asymmetric molecules** - chemicals that exist in two versions, where one is a mirror image of the other.
    - **Chemists often just want one of these mirror images** - particularly when producing medicines - but it has been difficult to find efficient methods for doing this.
    - Some molecules with mirror versions have different properties. An example is the **chemical called carvone**, which has one form that smells like spearmint and a counterpart that smells like the herb, dill.
    - **Different versions of the same molecule might have different effects** when ingested. Then it becomes important to be able to make only the mirror image of a drug that has the desired physiological effect.

Source: IE