



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

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