Nobel Prize in Chemistry 2022

For Prelims: Nobel Prize, Click Chemistry, Bioorthogonal Chemistry, Biotechnology

For Mains: Innovations & Discoveries in Science and Technology, Nobel Prize, Biotechnology

Why in News?

Carolyn R Bertozzi, Morten Meldal and K Barry Sharpless have been awarded the Nobel Prize **2022 in Chemistry** "for the development of **Click Chemistry and Bioorthogonal Chemistry".**

- **Sharpless** (won second time) came up with the term **'click chemistry'** and worked extensively on it.
- **Meldal,** independently of Sharpless, came up with a special chemical structure called **'triazole'** which has many significant applications.
- **Bertozzi** took the next step of developing click reactions that could work inside living organisms — 'bioorthogonal' reactions (a term she coined).
- **The 2021 Nobel Prize in Chemistry** was awarded to **Benjamin List and David MacMillan** for the development of **asymmetric organocatalysis.**

Note

K Barry Sharpless shared the 2001 Nobel Prize with William S. Knowles and Noyori Ryōji for **"Developing the First Chiral Catalysts".**

What is the Nobel Winners' Contribution in Click Chemistry?

- **Concept (Coined by Sharpless):**
  - Click Chemistry is a **minimalistic form of chemistry** in which **molecular building blocks can quickly and efficiently snap together.** It is a form of **simple and reliable chemistry**, where **reactions occur quickly,** and **unwanted by-products are avoided.**
  - The concept of Click Chemistry was **coined by Barry Sharpless around the year 2000, he found that instead of forcing carbon atoms**, the building blocks of organic matter, to bond with each other in the process of building molecules**, it's easier to link smaller molecules with complete carbon frameworks.**
  - The central idea is to **choose simple reactions between molecules** that have a **"stronger intrinsic drive"** to bond together, resulting in a faster and less wasteful process.
  - **Significance:** Chemists often try to recreate complex chemical molecules found in nature, and this has applications, among other things, in the field of medicine – how to target and block pathogens in cells. However, this process can be complicated and time-consuming.
    - Click chemistry, the robust method for building molecules, cannot provide exact

copies of natural molecules but it will be possible to find molecules that fulfil the same functions.

- **Azide - Alkyne Cycloaddition (Meldal and Sharpless):**
  - In the 2000s, **Meldal and Sharpless (independent of each other)** provided the **crown of Click Chemistry- the copper catalysed azide-alkyne cycloaddition.**
  - Meldal found that **adding copper ions to a reaction between an alkyne and an acyl halide** created a **triazole**, a stable ring-shaped chemical structure that's a **common building block in pharmaceuticals, dyes and agricultural chemicals.** Adding copper ions **helped control the reaction and create just one substance.**
  - Together, the **alkyne and the azide combined to make a triazole.** Azide is an **N_3 (Nitride Ion)** organic compound, whereas an alkyne is a hydrocarbon with at least one carbon-carbon triple bond.
    - This simple and effective chemical reaction is now widely used in the **development of drugs, mapping** Deoxyribonucleic Acid (DNA), and creating materials that are more **fit for purpose, among many other things.**
- **Bioorthogonal Reactions (Bertozzi):**
  - These reactions **work inside living organisms without disrupting the normal chemistry of the cell.**
  - Its use in combination with nanotechnology can lead to further developments in diverse areas of **biomedicine, such as molecular bioimaging, targeted delivery, in situ drug activation, study of cell–nanomaterial interactions, biosensing, etc.**
  - Using bioorthogonal reactions, **researchers have improved the targeting of cancer pharmaceuticals.**

How did Bertozzi develop Cancer Fighting Click Chemistry?

- **Spotting Glycans:**
  - While researching **glycans**, an elusive type of **carbohydrate found on the surface of cells that is crucial to the immune system**, Carolyn R Bertozzi wanted to attach **fluorescent molecules to glycans** so they could be **easily spotted.**
    - Bertozzi turned to the **same azide used by Sharpless and Meldal. The** azide not **only avoids interacting** with other parts of the cell, but it's also **safe to introduce in living beings.**
  - In 2004, she developed an **alternate click chemistry reaction** that worked **without toxic copper**, making it safe for living cells.
  - Bertozzi work is being used to **identify glycans on the surface of tumour cells** and block their **protective mechanisms that can incapacitate immune cells.**
    - This method is currently in **clinical trials for people with advanced cancer.** Researchers have also begun developing **"clickable antibodies"** that can help **track tumours and accurately** deliver **doses of radiation to cancer cells.**

Source: IE