# **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 <u>Nobel Prize</u> 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).
- <u>The 2021 Nobel Prize in Chemistry</u> 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<sub>3</sub> (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** <u>Deoxyribonucleic Acid (DNA)</u>, 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

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