Climate Adaptation of Marine Microalgae

For Prelims: Climate Adaptation of Marine Microalgae, Marine Microalgae, Global Warming, **Climate Change**, Rhodopsin.

For Mains: Climate Adaptation of Marine Microalgae, Developments and their applications and effects in everyday life, Environmental pollution and degradation.

Source: DTE

Why in News?

Recently, Scientists from **the University of East Anglia (UEA), England** have found that eukaryotic phytoplankton, also known as **Microalgae**, have adapted to **cope with** Global Warming and changing ocean conditions.

What is Marine Microalgae?

- Microalgae are **photosynthetic microorganisms** that can be found in diverse natural environments, such as water, rocks, and soil. They present **higher photosynthetic efficiency** than terrestrial plants, and are responsible for a **significant fraction of the world's oxygen production.**
- Marine microalgae play a pivotal role in the **oceanic food chain** and carbon dioxide absorption.
    - However, as climate change continues, **global warming is causing surface ocean waters** to warm, resulting in reduced nutrient availability due to **less mixing between the surface waters and nutrient-rich deeper waters.**
    - So nutrients become scarce at the surface, impacting **the primary producers such as microalgae** that are present in the top layer.
- This scarcity of nutrients, including iron, impacts the **primary producers like microalgae, causing them to produce less food** and capture less carbon dioxide from the atmosphere.
- Examples of Microalgae: **Diatoms, Dinoflagellate, Chlorella, etc.**

Note

Microalgae need sunlight and ample iron to produce food and absorb carbon dioxide, but 35% of the ocean's surface lacks sufficient iron for their growth.

What are the Key Findings of the Study?

- **Activate of a Protein called Rhodopsin:**
    - In response to the changing climatic conditions with the ocean surface, marine microalgae **activate a protein called rhodopsin**, similar to the protein responsible for **low-light**

vision in the human eye.
    - Rhodopsin allows these microalgae to **thrive by using sunlight as an alternative energy** source to traditional chlorophyll-based photosynthesis.
        - This adaptation is crucial for their survival, especially in regions with nutrient-poor surface waters due to ocean warming.
- **Capturing Light as Photosynthesis:**
    - Rhodopsins are the major light capturers in the ocean and can absorb as much light as **chlorophyll-based photosynthesis.**
    - Rhodopsins capture light to generate energy (in the form of adenosine triphosphate or ATP), helping **microalgae produce food** and capture carbon dioxide.

What are the Implications of this Study?

- **Environmental Adaptation:**
    - Understanding the role of rhodopsin in microalgae's adaptation to changing ocean conditions **can help mitigate the negative effects** of ocean warming on marine ecosystems.
    - This knowledge can be essential for **preserving ecosystems that rely on microalgae** as a food source.
- **Biotechnology Applications:**
    - Similar mechanisms could be employed in biotechnology to enhance the activity of **non-light-dependent microbes,** such as yeast. This could be valuable in the production of **various biotechnological products,** including insulin, antibiotics, enzymes, antivirals, and biofuels.
- **Global Agriculture:**
    - These findings also draw a parallel with land-based agriculture, where reduced nutrient availability can lead to reduced crop yields.
    - Just as microalgae rely on rhodopsin to adapt to changing conditions, there is potential to explore **strategies for enhancing crop resilience** in the face of **Climate Change.**

UPSC Civil Services Examination, Previous Year Questions (PYQs)

Q. Which one of the following is the correct sequence of a food chain? (2014)

(a) Diatoms-Crustaceans-Herrings
(b) Crustaceans-Diatoms-Herrings
(c) Diatoms-Herrings-Crustaceans
(d) Crustaceans-Herrings-Diatomsol:

Ans: (a)

Exp:

- The food chain is defined as the relation between organisms of different trophic levels which are connected to each other for food or energy. In a food chain the flow of energy or food is unidirectional and in a linear sequence. First, plants capture solar energy and then, food is transferred from the producers to decomposers.
- Diatoms are single celled photosynthesising algaefound in seas and oceans.
- Animals like crab, shrimps, lobsters, etc., are crustaceans and they eat diatoms.
- Herrings are fish and they eat crustaceans.
- Thus, **Diatoms → Crustaceans → Herrings forms the correct food chain.** Therefore, option (a) is the correct answer.