Geography-Post-cursor

GEO30 - Coral Reefs and Coral Bleaching

Coral reefs are vibrant marine ecosystems formed by tiny animals called coral polyps, which builds hard structures from calcium carbonate. They thrive in specific ocean conditions and play a vital role in marine life and coastal protection. Coral bleaching is a stress response that threatens these reefs.

Coral Reefs

Coral reefs are underwater ridges or mounds created by the accumulation of coral skeletons over thousands of years. They host symbiotic algae (zooxanthellae) that provide food through photosynthesis and give corals their bright colours.

Conditions for Growth:

- **Temperature:** Warm waters between 20°C and 30°C; corals cannot survive in cold or very hot conditions.
- **Depth:** Shallow areas, generally less than 50-70 meters, to allow sunlight penetration for algae.
- **Water Quality:** Clear, sediment-free water with moderate salinity (around 27-30‰) and good oxygen levels. Strong currents help supply nutrients, but avoid murky river mouths.
- **Location:** Found in tropical and subtropical oceans, away from the upwelling cold waters or high freshwater inflows

Types of Coral Reefs:

1. Fringing Reefs:

Fringing reefs are the most common type and grow directly from the shoreline of continents or islands.

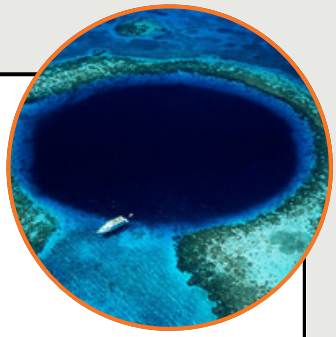
- **Structure:** They are attached to the land and expand seaward. They typically have a very shallow "reef flat" near the shore and a "reef slope" that drops off into deeper water.
- **Location:** Common in the Red Sea and parts of the Caribbean.
- **Example:** The Ningaloo Reef in Australia is the world's largest fringing reef.

2. Barrier Reefs:

Barrier reefs are similar to fringing reefs but are separated from the land by a wide, deep body of water called a lagoon.

- **Structure:** They run parallel to the coastline but sit further out at sea. The lagoon acts as a protective buffer between the reef and the shore.
- **Location:** These are far less common than fringing reefs.
- **Example:** The Great Barrier Reef in Australia is the most famous example, stretching over 1,400 miles.

3. Atolls:



Atolls are ring-shaped coral reefs that encircle a central lagoon but do not have an island in the middle.

- **Structure:** They often form when a fringing reef grows around a volcanic island that gradually subsides (sinks) into the ocean. The coral continues to grow upward toward the surface to stay in the sunlight, eventually leaving only a ring of coral behind.
- **Location:** Primarily found in the open Pacific and Indian Oceans.
- **Example:** The Maldives and the Lakshadweep Islands of India are composed of atolls.

Distribution:

- Concentrated in the Indo-Pacific region (e.g., Red Sea, Indian Ocean islands, Pacific islands) due to favourable conditions.
- Less common in the Atlantic (e.g., Caribbean) and absent from western coasts of continents where cold currents dominate.
- They cover less than 1% of the ocean floor but support immense biodiversity.

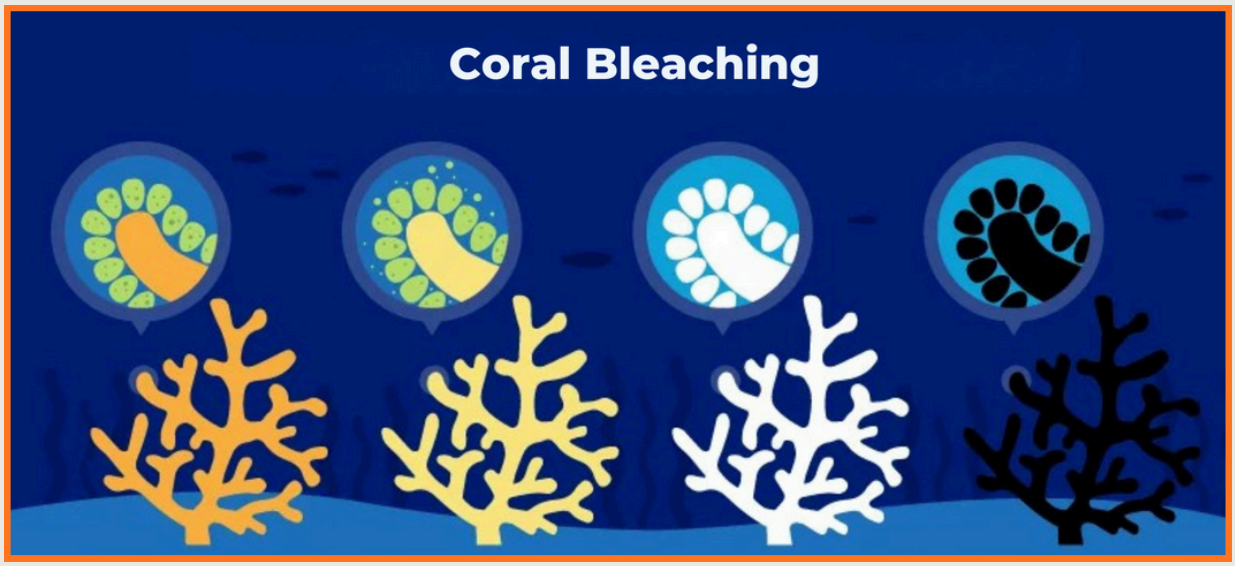
3. Atolls:

Importance:

- Act as natural barriers against waves and storms, protecting coastlines from erosion.
- Support diverse marine life, including fish, providing food and livelihoods through fisheries.
- Promote tourism and recreation; a source of medicines and building materials.
- Enhance ocean productivity by recycling nutrients.

Coral Bleaching

Coral bleaching is a stress response that occurs when the symbiotic relationship between corals and the microscopic algae living in their tissues breaks down. While a bleached coral is not yet dead, it is in a state of extreme vulnerability.



1. Causes:

The primary driver of coral bleaching is climate change, which leads to sustained increases in ocean temperatures.However, several other factors can trigger the response:

- **Thermal Stress:** An increase of as little as 1–2°C above the normal summer maximum can trigger bleaching.
- **Solar Radiation:** High levels of photosynthetically active radiation (visible light) and ultraviolet (UV) radiation.
- **Water Quality:** Runoff from storms carrying sediment or pollutants (like fertilisers and pesticides).
- **Ocean Acidification:** Rising CO^2 levels lower the ocean's pH, making it harder for corals to build their calcium carbonate skeletons.
- **Extreme Tides:** Exposure to air during abnormally low tides can cause shallow water corals to bleach.

2. The Process:

The process of bleaching is a biological "divorce" between the coral polyp and its resident algae, known as zooxanthellae.

- **Symbiosis:** In a healthy state, zooxanthellae live inside the coral's clear tissues. They provide the coral with up to 90% of its nutrients through photosynthesis, giving it its vibrant colours.
- **Stress:** When environmental conditions (such as heat) change, the algae's photosynthetic machinery is damaged. They begin to produce oxygen radicals (toxic molecules) that damage the coral's cells.
- **Expulsion:** To protect itself from these toxins, the coral polyp expels the algae into the surrounding water.
- **Bleaching:** Without the colourful algae, the coral's tissue becomes transparent, revealing the white calcium carbonate skeleton underneath.
- **Recovery or Death:** If conditions return to normal quickly, the coral can re-absorb algae and recover. If the stress persists for weeks, the coral starves and eventually dies.

3. Effects:

The consequences of mass bleaching events ripple through both marine ecosystems and human societies:

- **Loss of Biodiversity:** Coral reefs support over 25% of all marine life. When reefs collapse, thousands of species lose their habitat and nursery grounds.
- **Coastal Vulnerability:** Healthy reefs act as natural breakwaters, absorbing up to 97% of wave energy. Without them, coastal communities face increased erosion and storm surge damage.
- **Food Security:** Hundreds of millions of people depend on reef-associated fish for their primary source of protein.
- **Economic Impact:** Reef-related tourism and fishing generate billions of dollars annually. Bleached reefs lead to a significant decline in these revenues.

4. Mitigation:

Mitigation efforts focus on both global climate action and local management to build "reef resilience."

- **Global Carbon Reduction:** The most critical step is to reduce greenhouse gas emissions to stabilise global temperatures.
- **Marine Protected Areas (MPAs):** Establishing "no-take" zones reduces local stresses like overfishing and destructive anchors, allowing reefs a better chance to recover.
- **Pollution Management:** Improving wastewater treatment and reducing agricultural runoff to ensure cleaner water.
- **Restoration & Science:** Techniques like coral gardening (growing heat-resistant corals in nurseries) and shading (using artificial structures or mist to block intense sunlight) are being tried to protect high-value reef sections.