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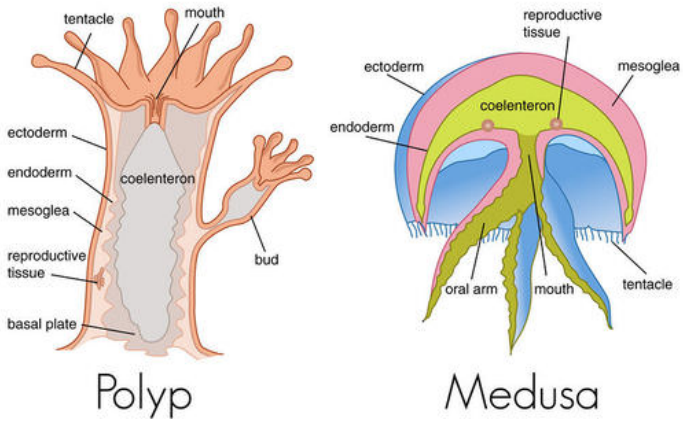
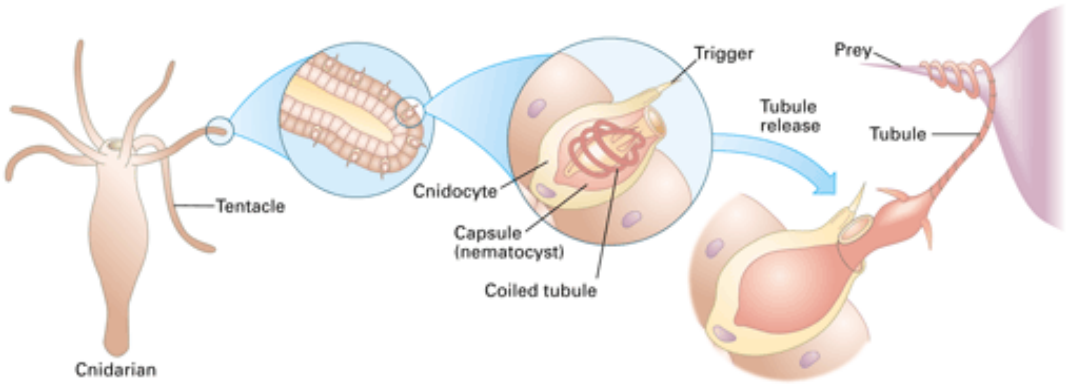
PHYLUM – COELENTERATA / CNIDARIA

Definition : Coelenterata may be defined as diploblastic metazoa with tissue grade of construction having nematocyst and a single gastrovascular cavity or the coelenteron.

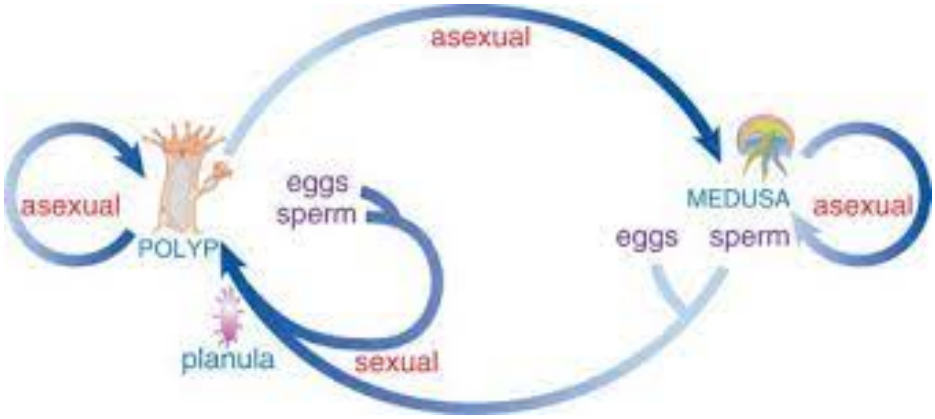
General Characteristics

1. They are aquatic, mostly marine except few freshwater forms like *Hydra*.
2. They are multicellular with tissue grade of organization.
3. They are solitary or conical. Sedentary or free-swimming.
4. Individuals are radially or bi-radially symmetrical about a longitudinal oral-aboral axis.
5. Body organization of cell-tissue grade. Cells are mostly scattered and specialized for different functions. Some cells form tissues like nerve nets or nervous tissues.
6. Exoskeleton chitinous (perisarc) or calcareous(corals).
7. They are diploblastic animals with 2 cellular layers- an outer epidermis and an inner gastrodermis- with a gelatinous acellular mesoglea in between.
8. Acoelomate animals because they do not pose a second body cavity, the coelom.
9. Short and slender tentacles encircle the mouth in one or two whorls.
10. The tentacles are provided with nematocysts; tentacles serve for food capture, ingestion, serve for adhesion, and defence.
11. Two types of individuals occur, attached sessile and asexual zooid (**polyps**) and free swimming and sexual zooid (**medusae**). Some species are notable for polymorphism or variety of forms.





12. They are usually carnivorous; digestion is extracellular as well as intracellular.
13. No anus.
14. Coelom and respiratory, circulatory, and excretory system wanting.
15. Nervous system primitive, consisting of a diffuse nerve net. Central nervous system absent.
16. The muscular system includes longitudinal and circular fibers formed by epithelia-muscle and endothelial-muscle cells.
17. A single cavity, lined with gastrodermis, called gastrovascular cavity or coelenteron, into which mouth opens.
18. Sensory organs form ocelli and statocysts.
19. Reproduction is both by asexual and sexual methods.
20. Asexual reproduction occurs by budding and sexual reproduction by the formation of gametes.
21. The development includes a free-swimming ciliated planula larva.
22. Life history exhibits the phenomena of alternation of generation or metagenesis in which the asexual polypoid, sessile generation alternates with sexual medusoid, free-swimming generation.



Classification (up to Class)

According to Hyman, L.H., (1940), Phylum Coelenterata has been classified into 3 classes.

Class 1 : **Hydrozoa** (Greek hydra=water + zois=animal)

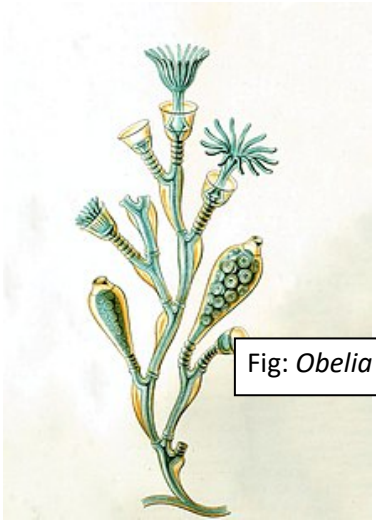


Fig: *Obelia*

i. Freshwater or marine. Solitary or conical. Sessile or free-swimming.
ii. Exhibit tetramerous and polymerous radial symmetry.
iii. The body wall consists of outer ectoderm and inner endoderm separated by non-cellular mesoglea.
iv. Gastrovascular cavity without stomodaeum, septa, or nematocysts bearing gastric filament.
v. Skeleton or horny structure is horny perisarc in some forms, while coenosarc secretes a skeleton of calcium carbonate forming a massive stony structure or coral in other forms.
vi. They exhibit polymorphism. These are two main types of zooids, the asexual polyp, and sexual medusa.
vii. Polyp without stomodaeum and septa (mesentery).
viii. Medusa with true velum (Craspedote).
ix. Mesoglea non-cellular.
x. Many of them exhibit alternation of generations.
xi. Gonads are epidermal. Sex cells shed directly on the outside.
xii. Cleavage is holoblastic, embryo ciliated in planula.

Examples: *Hydra, Tubularia, Obelia, Millepora* , *Physalia*

Class 2 : **Scyphozoa** (Greek skyphos=cup + zois=animal)

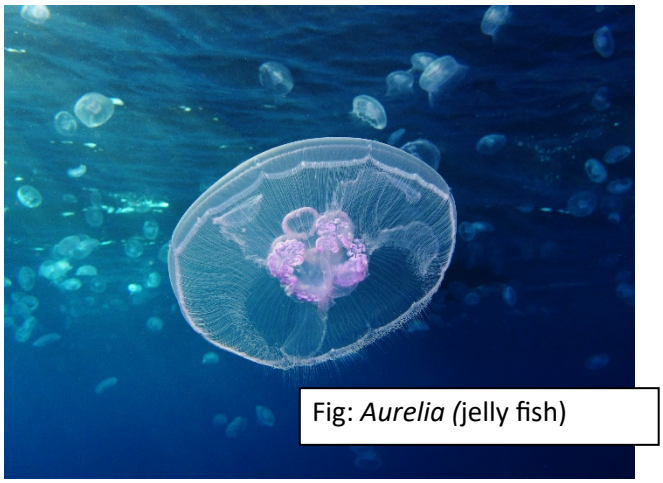


Fig: *Aurelia (*jelly fish)

i. It includes large jelly-fishes or true medusae that are exclusively marine.
ii. Medusae are large, bell or umbrella-shaped, without true velum, free-swimming, or attached by an aboral stalk.
iii. Polyp stage reduced or absent.
iv. Marginal sense organs are tentaculocysts having endodermal statoliths.
v. Gastrovascular cavity with gastric pouches and endodermal gastric filaments. No stomodaeum.
vi. Mesoglea extensive, gelatinous, with fibers and cells.
vii. Gonads are gastrodermal. Sex cells released in the digestive cavity.

Examples: *Aurelia, Rhizostoma, Periphylla, Lucernaria*

Class 3 : **Anthozoa** (Green Anthos=flower + zois=animal)

i. Exclusively marine. Solitary or conical.
ii. Exclusively polypoid.
iii. No medusoid stage.
iv. The body is usually cylindrical with hexamerous, octamerous, or polymerous biradial or radobilateral symmetry.
v. The oral end of the body is expanded radially into an oral disc bearing hollow tentacles surrounding the mouth in the center.
vi. The stomodaeum is present, often provided with 1or more ciliated grooves the siphonoglyphs.
vii. The gastrovascular cavity subdivided by 8 or more septa or mesenteries.
viii. Mesenteries bear nematocysts at their inner free edges.
ix. Mesoglea stout and contains fibrous connective tissue and amoeboid cell.
x. Skeleton either external or internal.
xi. The exoskeleton is formed from calcium carbonate which often forms a massive coral.
xii. The nervous system is in the form of a typical nerve net without a concentrated central nervous system.
xiii. Endodermal gonads, develop in the mesenteries.
xiv. The ripe sexual products are discharged into coelenteron.
xv. External fertilization.
xvi. The fertilized egg develops into a planula larva, which after a short free life settles down and develops into an adult.

Fig: *Pennatula* (Sea pen)

Examples: *Tubipora, Telesto*, *Gorgonia, Pennatula*

POLYMORPHISM IN CNIDARIA

Definition: The occurrence of more than one type of structurally and functionally different individuals within a population is called polymorphism. The class Hydrozoa of phylum Coelenterata includes a large number of colonial species that contain more than one form of individuals which are called zooids.

Coelenterates have two basic zooids, **polyp** and **medusa**. All other types of zooids are modifications of these two types of zooids.

- Polyp has a tubular body with a mouth surrounded by tentacles at one end. Other end is blind and usually attached by a pedal disc to the substratum. Polyps are typically sessile. Polyps are concerned with feeding, protection and asexual reproduction.
- Medusa has a bowl or umbrella shaped body with marginal tentacles and mouth is centrally located in a projection called manubrium on the ventral concave surface. Medusae are generally motile and concerned with sexual reproduction.

Polyp and medusa are in fact homologous structures and from one another can easily be derived.

Modifications of Polyp

i. Gastrozooids or feeding zooids are typical polyps with a mouth and surrounding tentacles.
ii. Dactylozooids which are used for defence are polyps without mouth and usually with a long basal tentacle.
iii. Gonozooids are reproductive zooids derived from polyp, which produce sexual medusae or gonophores.

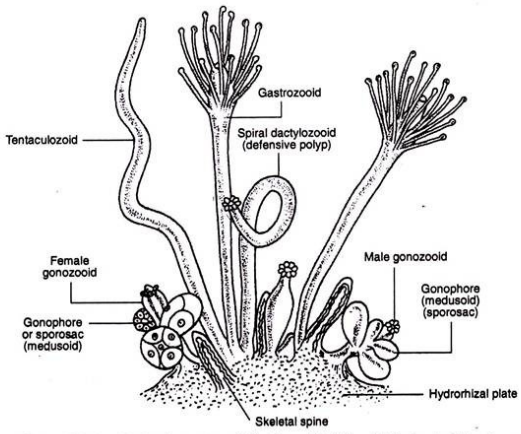


Fig. 12.35: Colony of *Hydractinia* showing gastrozooid, dactylozooid (spiral zooid), tentaculozooid and gonozooids.

Modifications of Medusa

i. Nectophore or nectocalyx or swimming bell is a medusa modified for sexual reproduction.
ii. Pneumatophore or float is a bladder-like modified medusa filled with mixture of gases and helping the colony to float on the surface.
iii. Phyllozooid or bract is leaf-like zooid, studded with nematocysts and serving to protect the colony.

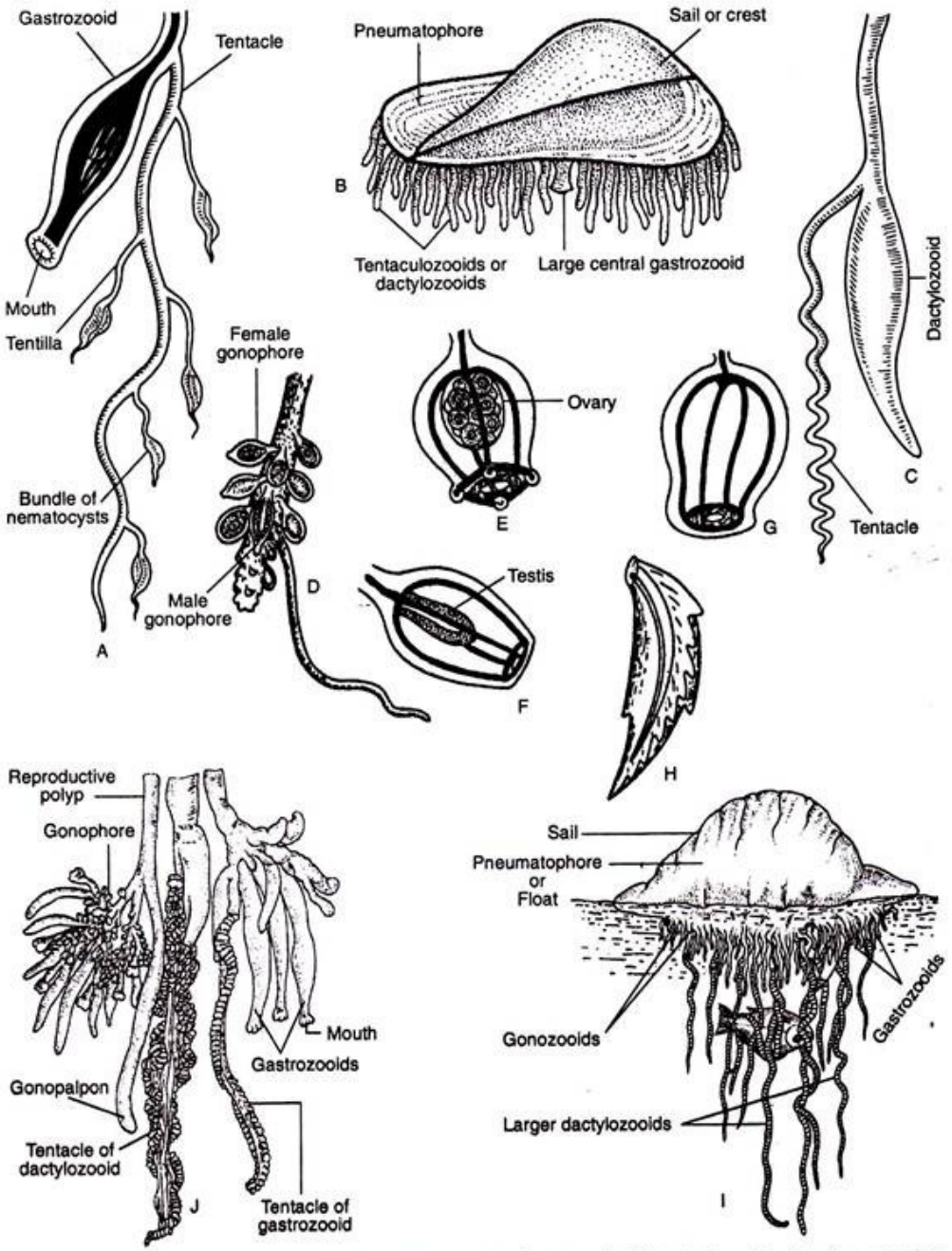


Fig. 12.34: Different types of zooids (after various sources). A. Gastrozooid with tentacle and bundle of nematocysts. B. Central gastrozooid of *Velella*. C. Dactylozooid with tentacle. D. Gonozooid. E. Female gonophore (medusoid form). F. Male gonophore (medusoid form). G. Nectophore or swimming bell. H. Bract or hydrophyllium. I. *Physalia*, Portuguese man-of-war, showing the pneumatophore or float. J. Part of *Physalia*.

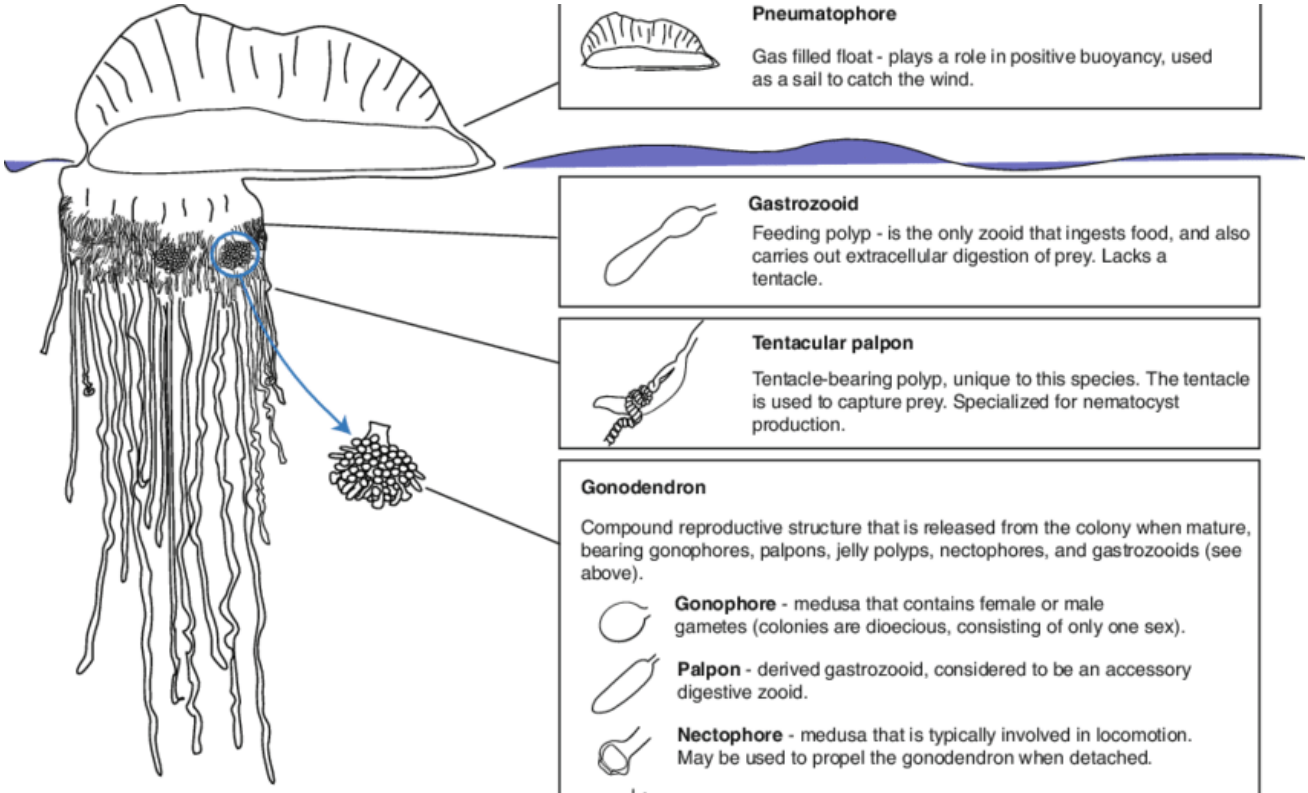


Fig:Different types of zooids in *Physalia* (man-o-war)

TYPES OF POLYMORPHISM

A few coelenterates, such as Hydra and sea anemone are monomorphic in which only polyp stage is found but other coelenterates exhibit polymorphism.

1. **Dimorphism**: Many hydrozoan colonies like *Tubularia* and *Campanularia* have only two types of zooids, the feeding zooids or gastrozooids and medusae or nectophores that bud off from the stem or gastrozooids. These are dimorphic colonies in which blastostyles are not present.
2. **Trimorphism**: Some species like *Obelia* and *Plumularia* are trimorphic because besides gastrozooids and medusa, they also have medusa-producing gonozooids or blastostyle.
3. Polymorphism: Coelenterates having more than three types of individuals are called polymorphic, e.g. *Hydractinia* which has five types of zooids, each performing a specialized function. Gastrozooids are for feeding, spiral dactylozooids for protection, long tentaculozooids have sensory function. Skeletozooids are spiny projections of chitin for protection and gonozooids are reproductive zooids that produce male or female medusae.
4. **Highly modified polymorphism**: In order Siphonophora, such as *Diphyes, Halistemmia, Stephalia* and *Physalia*, zooids are so much modified that they appear like organs of a single body rather than individuals of a colony. They are mostly pelagic in habit. In *Physalia*, zooids are in units called cormidia,

which bear gastrozooids, small and large dactylozooids with long and short tentacles and branched gonozooid with gonophores. In *Diphyes* colonies are linear with one or more nectophores located at the apical end. Cormidia are also repeated in a linear succession. In *Velella* and *Porpita*, there is a single large central gastrozooid with a mouth, around which are arranged concentric rows of gonozooids and dactylozooids. The whole colony looks like a single individual.

ORIGIN OF POLYMORPHISM

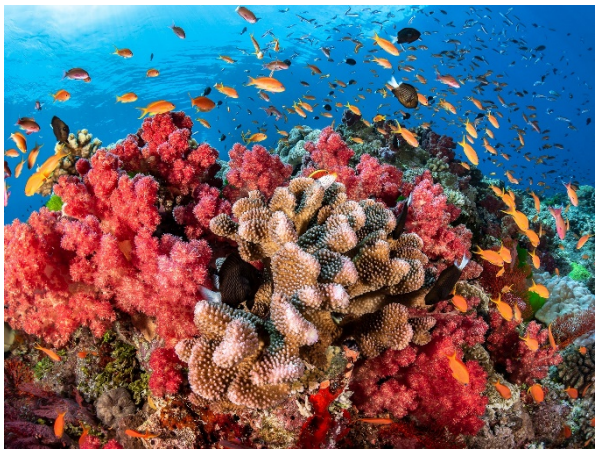
There are two theories to explain the origin of polymorphism in coelenterates.

- **Polyorgan theory**: This theory was proposed by Huxley (1859), Eschscholtz (1829), E. Metschnikoff (1874) and Muller (1871), according to which individuals of a colony are actually organs of a medusoid individual, which have multiplied and migrated from their primitive positions to the current evolved positions.
- **Polyperson theory**: This theory was first proposed by Leuckart (1851), Vogt (1848), Gegenbaur (1854), Kolliker (1853), Claus (1863) and later strongly supported by E. Haeckel (1888), Balfour (1885) and Sedgewick (1888). According to this theory colony is not a single individual but various parts of the colony are modified individuals which have changed their structure due to division of labour. They have all modified from the primitive zooid which was a polyp.
- **Medusome theory**: This theory was proposed by Haeckel (1888) as a compromise between the above theories. The theory says that the siphonophore larva formed from gastrula was a medusoid individual, from which zooids or persons appeared by budding from the subumbrella.

SIGNIFICANCE OF POLYMORPHISM:

The phenomenon of polymorphism is essentially one of division of labour in which specific functions are assigned to different individuals. Thus, polyps are modified for feeding, protection and asexual reproduction, while medusae are concerned with sexual reproduction. This distribution of functions among diversified individuals and their subsequent modifications in coelenterates may have resulted from their initial simple organization and lack of organ specialization. Polymorphism gave the colonies competitive edge in protection and food gathering and eventual survival.

CORALS & CORAL REEF FORMATION

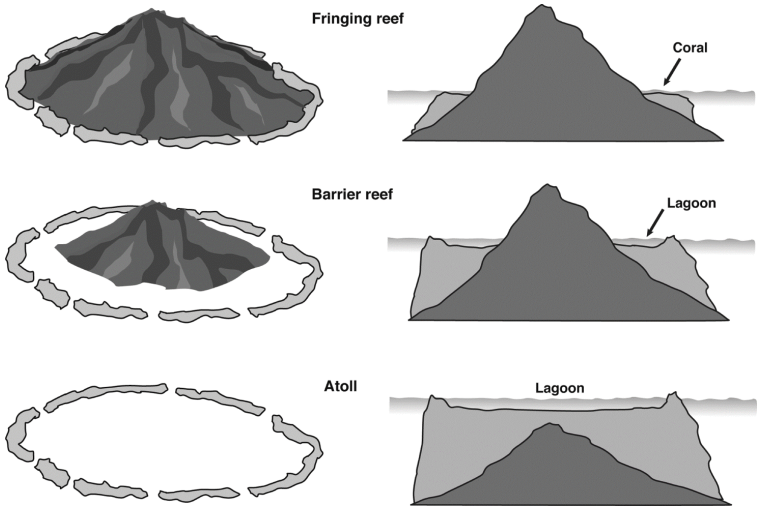


Corals: Corals are marine invertebrates belonging to the Cnidaria phylum. There is a close relationship between them and jellyfish and sea anemones. Corals are commonly found in warm, shallow seas, where they form colonies composed of several coral polyps. These polyps exude calcium carbonate exoskeletons that constitute the framework of coral reefs.

Coral Reef: Coral colonies grow continuously in size by budding of polyps and often form extensive masses, known as coral reefs. Reef building corals require warm shallow waters (normally above 20C). They are therefore limited to the Indo-Pacific, the Central-Western Pacific, and the Caribbean regions north of Bermuda.

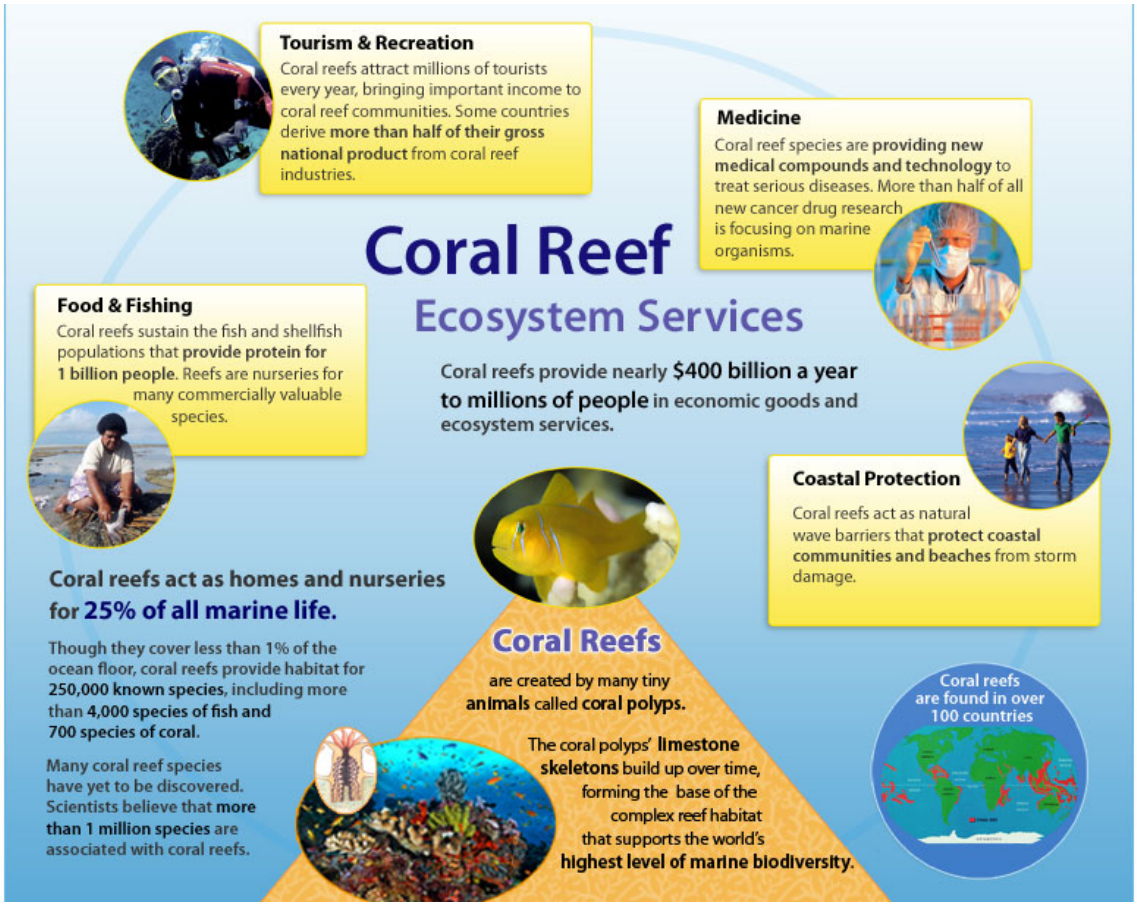
Kinds of Coral Reefs:

1. Fringing reefs: Fringing reefs are the most common type of coral reef and are situated near to the shore, either surrounding islands or along the coastline. These reefs grow immediately from the coast and, depending on the depth of the surrounding water, can be shallow or deep. Between the reef and the beach, there is typically a narrow, shallow lagoon.
2. Barrier reefs: Barrier reefs are similar to fringing reefs, with the exception that they are separated from the shore by a deeper lagoon or channel. These reefs are frequently located further offshore, separated from the mainland by a deep canal. Australia's Great Barrier Reef is the world's largest barrier reef.
3. Atoll: Atoll reefs are circular or horseshoe-shaped reefs which encircle a central lagoon. They are constructed atop a submerged volcano or seamount that has subsided through time and are typically found in the open ocean. In the Indian and Pacific Oceans, including the Maldives and the Marshall Islands, there are atoll reefs.



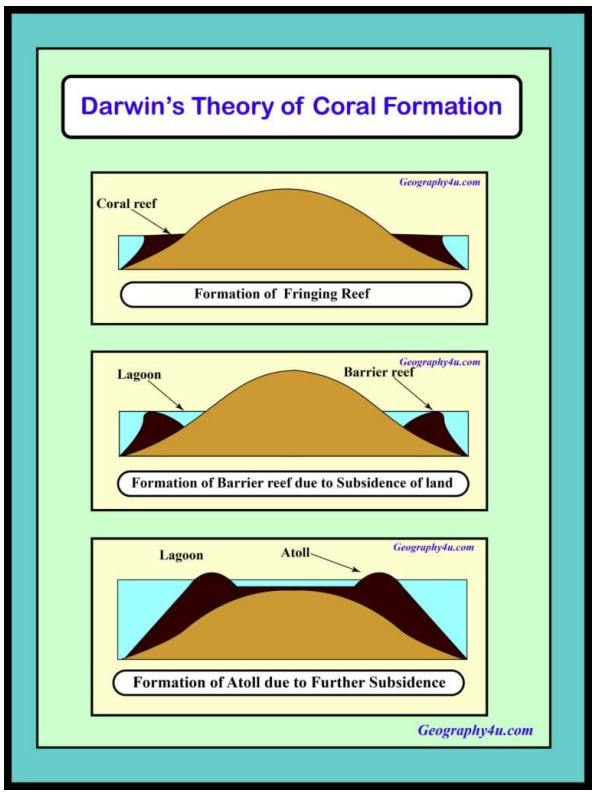
Importance of coral reefs: Coral reefs are vital ecosystems that give countless advantages to the earth and its inhabitants. Here are some of the most essential reasons why coral reefs are crucial:

1. **Biodiversity**: Coral reefs are among the most biodiverse ecosystems on the globe, as they provide home and protection for a huge array of marine organisms. They are commonly known as the "rainforests of the sea."
2. **Fisheries**: Coral reefs are significant fisheries, supplying food and a means of subsistence for millions of people throughout the world. They contribute to the fishing industry by serving as a habitat and breeding ground for numerous economically valuable fish species.
3. **Coastal protection:** Coral reefs create a natural barrier that aids in preventing erosion and storm damage to coastlines. In addition, they assist absorb the energy of waves and storms, mitigating their negative effects on coastal areas.
4. **Tourism**: Coral reefs are a popular tourist attraction and a substantial contributor to the worldwide tourism sector. They enable snorkelling, scuba diving, and other recreational activities.
5. **Scientific research:** Scientists do research on coral reefs to better comprehend the biology of coral and the marine creatures that inhabit there. This research can benefit in the creation of novel medicinal therapies and conservation activities.
6. **Climate regulation:** Coral reefs have a significant part in regulating the climate of the Earth. They are able to absorb and store enormous quantities of carbon dioxide, so contributing to the reduction of greenhouse gases in the environment.



FORMATION OF CORAL REEFS: Many hypotheses have been proposed to explain the origin of coral reefs. Yet, just a few are suitable. These are the hypotheses that adequately explain the creation of coral reefs.

- **Subsidence theory:**
  - Darwin presented this hypothesis regarding subsidence in 1831.
  - According to this notion, all known coral reefs are located in places that have experienced land subsidence. He argues that corals initially form as bordering reefs around the coasts of islands in tropical shallow waters. Subsidence of the islands began, resulting in the transformation of the bordering reef into a barrier reef separated by a lagoon. Although additional sinking of the island results in the island's disappearance, an atoll is formed.



- **Glaciation control theory:**
  - The hypothesis of glaciation control was proposed by Albrecht Penck and Reginald Daly.
  - They argued that the creation of ice caps during the glacial period dropped the water level by 60-70 metres. At that time, temperatures were quite low. Eventually, ice evaporated and the temperature increased. Corals began to grow on the ocean floor's flat platform and kept pace with rising sea levels to construct enormous reefs.