UG CBCS Semester-1
Obelia

Obelia is a sedentary colonial marine cnidarian which grows upright in a branching tree-like form and has several specialized feeding and reproductive polyps. It is commonly called sea-fur and exists in both asexual, sessile, polypoid stage and sexual, free-swimming medusoid phase.

Habit and Habitat
Obelia is cosmopolitan in distribution, only exception being the high-arctic and Antarctic seas. They grow in shallow water, in intertidal rock pools and are usually found up to 80-100 meters of depth from the water's surface. The medusa stage of *Obelia* species is commonly found in coastal and offshore plankton around the world. The colonies of *Obelia* are often found as a delicate fur-like growth on the rocks, stones, mollusc shells, sea weeds, wooden pilings and wharves. *Obelia geniculata* normally grows on kelp fronds, especially on *Laminaria hyperborea* in conditions of moderate wave exposure.

Morphology
Obelia is a very small marine hydroid. It looks like a small branching tree exhibiting whitish or brown colour. The height of *Obelia* varies from 2 cm or more. The body of *Obelia* consists of two kinds of filaments, horizontal **hydrorhiza** and vertical **hydrocaulus**.

Fig. 4: Colony of *Obelia geniculata*

a) **Hydrorhiza (Root of a hydroid)**
Hydrorhiza is the basal part of the colony consisting of tubular processes called **stolons**. It encrusts over the surface of substratum and helps in the attachment of the colony.

b) **Hydrocaulus (Stem of a hydroid)**
A few small vertical filaments, 2-3 cm long, arise from the hydrorhizas. These are called **hydrocauli**. Each hydrocaulus branches alternately, each of which terminates into a polyp. The polyps collectively are termed as **zooids**. These zooids are nutritive in function and help in feeding. These are called **gastrozooids**. The axils of proximal branches bear cylindrical reproductive zooids. These are termed as **gonozooids**, **blastozooids** or **blastostyles**.

Living Tissue of *Obelia*
Coenosarc
Whole colony of *Obelia*; hydrorhiza, hydrocaulus and zooids; contain living tissue, called **coenenchyme** or **coenosarc.** The coenosarc is diploblastic comprising of two layers; outer **epidermis** and inner, **gastrodermis**. A middle non-cellular layer of **mesoglea** is present in between epidermis and gastrodermis. A narrow canal, called **coenosarcal canal** runs through whole colony of *Obelia* which is continuous with the gastrovascular cavity of the zooids. The continuity of the canal system helps to transport the digested food throughout the colony.

Epidermis

The epidermis is thin and made up of typical cells of Cnidaria. These include; epithelio-muscular cells, mucus-secreting cells, interstitial cells, nerve cells and nematoblasts. The nematocysts are **basitrichous isorhizas**. These consist of an oval capsule, a long thread bearing spines and open at the tip.

Gastrodermis

It forms the lining of gastrovascular cavity and consists of endothelio-muscular cells, nutritive cells, gland cells and nerve cells.

Protective Covering – Perisarc

Entire colony of *Obelia* is surrounded by a protective covering, called perisarc. It is non-cellular, tough, transparent, yellowish-brown and cuticular in nature and is called **perisarc** or **periderm**. It makes the vertical part of the colony firm and rigid. Perisarc is secreted by the epidermis and is separated from the coenosarc by a thin fluid-filled space. However, the coenosarc and perisarc are in contact making the colony more rigid. At some points, the perisarc is arranged in flexible rings called **annuli**. These allow the swaying movements due to the force of water currents. The perisarc of hydranth is termed as **hydrotheca** and that of gonozooid is called **gonotheca**.

Morphology of a Gastrozooid

Gastrozooid of *Obelia* is a feeding polyp. Its function is to **feed the whole colony**. Gastrozooid is a **tubular** and **diplobastic** zooid with a **central gastrovascular cavity** continuous with the coenosarcal canal. The polyp is attached to the hydrocaulus by a **hollow stalk** while its distal end is produced into a conical elevation called **manubrium** or **hypostome**. The apical portion of the manubrium bears a **terminal mouth** encircled by numerous long, **solid tentacles**, often 24, loaded with nematoblasts. The perisarc of gastrozooid, called **hydrotheca**, is transparent and cup-shaped invaginated as a **platform** or **shelf** at the base of the gastrozooids for polyp to rest. The gastrozooid and hydrotheca collectively form **hydranth**. In case of any emergent situation, the polyp can withdraw itself into the hydrotheca and the tentacles fold over the manubrium covering the mouth. The presence of shelf prevents the polyp to retract into the hydrocaulus. The **annuli** of the perisarc present around the stalk of polyp allow the swaying movements due to the force of water current.

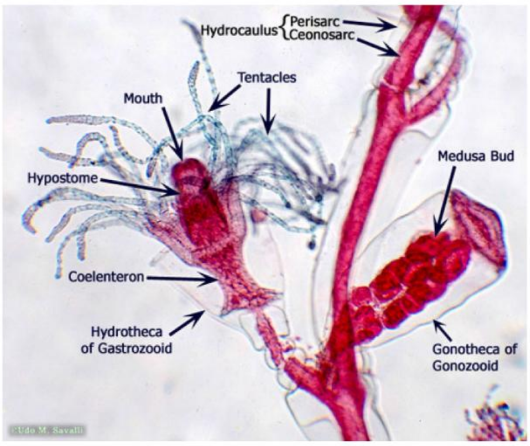


Fig. 7: Structure of a gastrozooid and gonozooid

Morphology of a Gonozooid

The gonozooids, also called **blastozooids** or **blastostyles** are cylindrical rod-like reproductive bodies present in the axils of hydrocaulus and stalk of gastrozooids. Gonozooids are **less in number** than gastrozooids as these are present only in the proximal part of the colony. It has a **reduced gastrovascular cavity** and is **devoid of mouth and tentacles**. It, thus, can not feed and receives food digested by the gastrozooids and transported through the gastrovascular cavity. Like other parts of the colony, gonozooids are also enclosed in a perisarc, called **gonotheca**. It is constricted distally and constricted by annuli proximally. The apical part of the gonotheca has an opening called **gonopore**. Gonozooid produces numerous small **medusae** or **gonophores** by the asexual process of budding. Mature medusae detach from the gonozooids and escape into the surrounding water through the gonopore. The gonozooids, gonophores and gonotheca collectively form **gonangium**.

Morphology of a Medusa

Medusa of *Obelia* is radially symmetrical, umbrella-like zooid which measures approximately 6-7 mm in diameter. The outer surface of medusa is convex and known as **ex-umbrellar surface,** while the inner concave surface is called **sub-umbrellar surface.** A short **manubrium** containing a **quadrangular mouth** at its distal end hangs from the centre of the sub-umbrellar surface. The medusa is **craspedote** type as its edge is produced inwards into an insignificant rudimentary velum. The margins of the medusa bear initially 16 short, contractile **tentacles**; which gradually increase in number. The mouth open into a short **gullet** which leads to a wide expanded **stomach** from which arise four narrow, **radial canals** which mark the four principal **per-radii**. The radial canals extend till the margin of the umbrella and open into a **circular canal** running parallel to the margin.

Fig. 8: Oral view of a medusa

The radius bisecting two per-radii is called **inter-radius** (four in number) and that bisecting per-radius and adjacent inter-radius is termed as **ad-radius** (eight numbers). The tentacles present at the end of these radii are named accordingly, such as per-radial tentacles; inter-radial tentacles and so on. Whole system of canals is lined by inner layer of gastrodermis and both the ex-umbrellar and sub-umbrellar surfaces are covered by epidermis. Nervous system consists of two diffused nerve nets which are concentrated around the margins of the umbrella and form **two circular nerve rings**. Eight receptor organs, called **statocysts,** are present at the bases of ad-radial tentacles. These are the organs of balance, muscular co-ordination and equilibrium. Medusa possesses **four gonads** on the sub-umbrellar surface. These are per-radial in position and each of these is present in the middle of each radial canal. These are **dioecious**, male and female medusae being separate individuals.

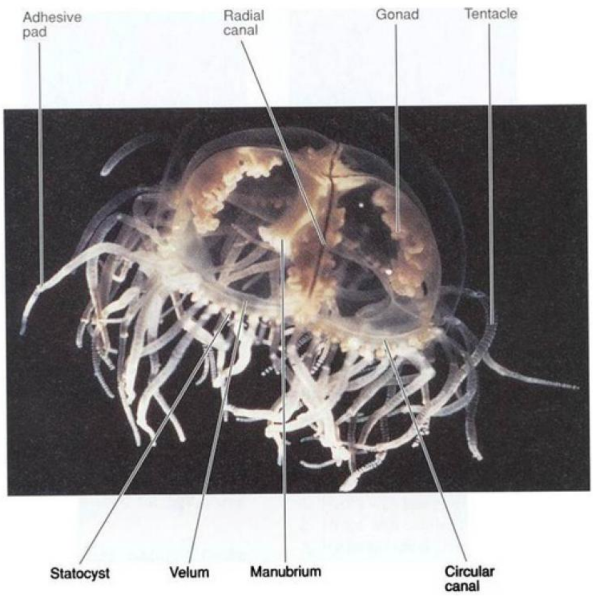


Fig. 9: Lateral view of a medusa

Locomotion in *Obelia*

Movement in Polyps

The polypoid colony of *Obelia* is sessile and attached to the substratum. It does not move from place to place. However, polyps exhibit certain movements under the force of water currents due to the presence of annuli in the perisarc. The polyps can also undergo contraction and extension because of the presence of longitudinal and circular muscles in their body wall.

Locomotion in Medusa

a) **Hydro propulsion**: Medusae are free swimming forms. They generally swim in the water by **jet propulsion method.** The contraction and expansion of bell muscles alternatively closes and opens the bell which forces water out of the sub-umbrellar cavity downwards and propels the body in upward direction. The contraction of the epidermal muscle tails of the sub-umbrellar surface helps in the closure of the bell cavity while the opening of the bell is brought about by elastic mesoglea and contraction of the muscle tails in the middle of upper surface. This kind of jet propulsion method is called **hydro propulsion**.

b) **Passive drifting**: Medusae also drift and float passively in sea water under the force of strong water currents and wind. Thick mesoglea of medusae provides them buoyancy and helps in floating.

Nutrition in *Obelia*

Nutrition in Polyps

The gastrozooids are the nutritive zooids of the *Obelia* colony. They are primarily carnivorous and feed upon small crustaceans, tadpoles, worms, insect larvae, etc. The gastrozooids capture the food with the help of nematocysts present on the tentacles. The food is pushed into the gastrovascular cavity through the mouth where the proteolytic enzymes secreted by the gastrodermal gland cells partially digested the food. The semi-digested food is engulfed by the food vacuoles of the nutritive cells for complete digestion.

Thus, digestion is both **extracellular and intracellular**. The digested products of the food are distributed throughout the body by cell-to-cell diffusion helped by beating of flagella of gastrodermal cells; the gastrovascular cavity thus serving for both digestion and transportation of food. The undigested food material is egested through the mouth of the gastrozooids.

Nutrition in Medusa

The process of feeding in medusa is similar to that in polyps. Medusa is strictly carnivorous and captures food with the help of tentacles beset with nematocysts. As in polyps, the food is digested both extracellularly and intracellularly but exclusively in stomach. The digested food is distributed to whole body through the network of radial and circular canals present in medusa.

Respiration in *Obelia*

Obelia does not have any respiratory organs and the gas exchange takes place by diffusion through the general body surface. Oxygen diffuses directly from the surrounding water into the epidermal cells and carbon dioxide is diffused out.

Morphology and Physiology of *Obelia*

The diffusion of gases can also take place during circulation of water in the gastrovascular cavity of polyp or medusa as there is a continuous influx of water. Here, exchange of gases takes place between water and the gastrodermal cells from where oxygen diffuses to each cell of *Obelia*.

Excretion and Osmoregulation in *Obelia*

Obelia does not have special excretory or osmoregulatory organs. It excretes nitrogenous waste in the form of **ammonia** that diffuses through the body wall. Excess water is thrown out of the gastrovascular cavity through the mouth. Thus, mouth being the single opening functions as a contractile vacuole also.

Sense Organs

Statocyst

Polyps of *Obelia* are sessile zooids and they do not require any sense organs. However, medusae are free-swimming zooids and while swimming, their body may tilt and lose balance. Thus, they possess balancing organs, **statocysts** with the help of which they can regain their position. **Structure** A statocyst is a **fluid-filled sac** lined by sensory epithelial cells. The basal part of the cells is connected to the nerve cells while the inner ends bear sensory processes. The cavity of statocyst contains a round particle of calcium carbonate, called **statolith** or **otolith**. The particle is movable and is secreted by a large cell, **lithocyte**.

The statocysts help in **balance and equilibrium** of medusa. While swimming, if the medusa tilts, the movable particle of statolith rolls over the tilted side and presses against the sensory processes. The stimulated cells transmit the nerve impulse to the nerve ring which is connected to the muscle tails. The nerve impulse causes the rapid contraction of the muscle tails of the stimulated side regaining the original position of medusa. **Reproduction in *Obelia*** The life cycle of *Obelia* includes both polyp and medusa stages. Polyp is an asexual form and reproduces by asexual means while medusa is a sexual zooid and reproduces sexually.

a) Asexual Reproduction

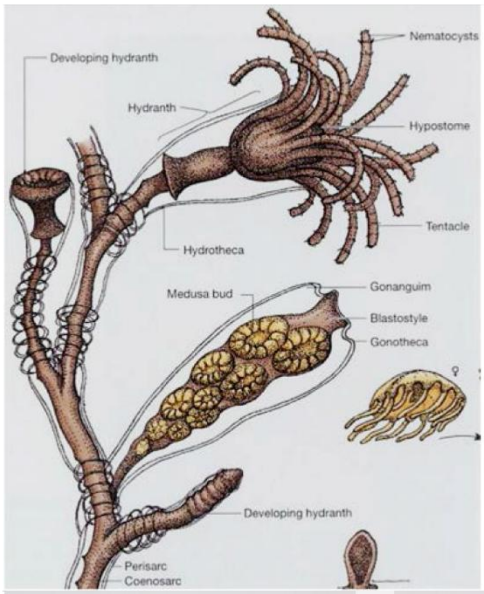
The polyps reproduce asexually by the process of **budding**. The hydrocaulus gives rise to a number of gastrozooids and as the colony matures, blastostyles bud from the axils of proximal gastrozooids and hydrocaulus. Each blastostyle produces a large number of **medusa buds** in spring and summer. These buds gradually develop and mature. When fully formed, they detach from the blastostyles and escape into the water through the gonopore.

b) Sexual Reproduction

The sexual reproduction in *Obelia* takes place in the medusa stage; the male and female medusa being separate. The medusae produce ova and sperms and release them into the water where fertilization takes place. Sperms may also enter the female medusa along with the water current and fertilization may take place inside the body of female medusa.

Development of Fertilized Egg

The fertilized egg undergoes **complete and equal cleavage** resulting in the formation of solid ball of cells, called morula. It develops a central cavity, blastocoel surrounded by loosely arranged blastomeres. This hollow blastula is termed as **coeloblastula**. Gradually, the new cells cut off from the blastomeres and start migrating in the blastocoel from one end of the coeloblastula. Slowly, entire blastocoel is filled with the cells and hollow blastula converts into solid gastrula, called **stereogastrula** by delamination. The outer surface of the embryo becomes ciliated forming a ciliated larva, **planula**



larva. It is double layered ovoid larva, consisting of outer ciliated ectoderm and inner solid mass of endodermal cells. It actively swims in the water and helps in the dispersal of species. After a short period of time, the larva settles down and attaches itself to the substratum by one of its ends. The attached end forms a basal disc while a mouth surrounded by tentacles is formed at the distal end. This sessile stage is termed as **hydrula stage** as it resembles a hydra. Gradually, hydrula undergoes asexual reproduction repeatedly and converts into an adult *Obelia* colony.

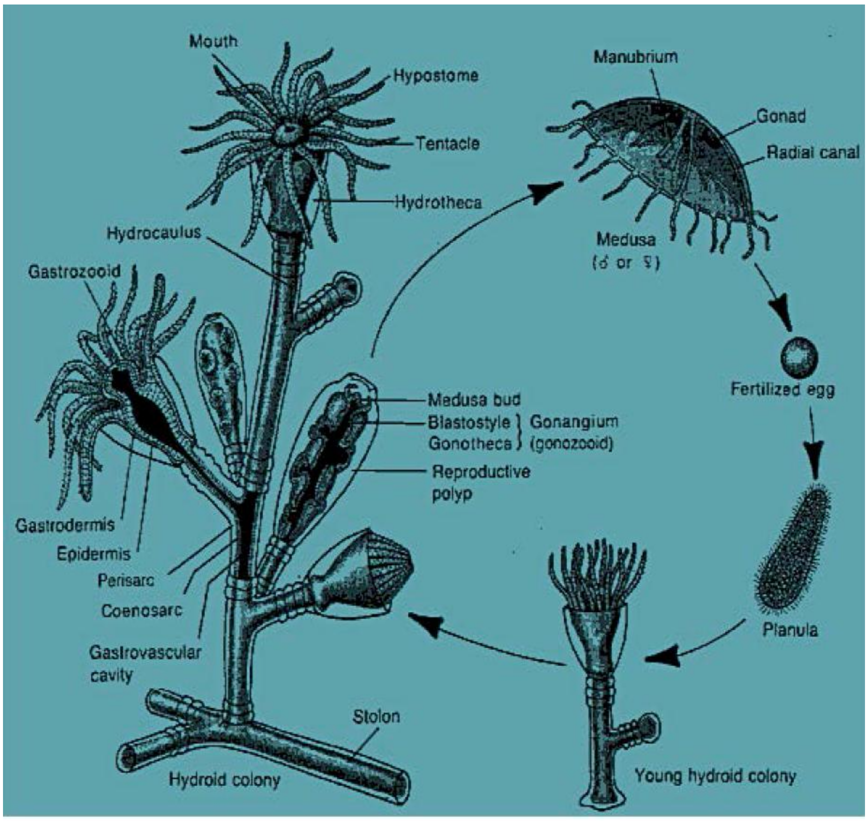


Fig. 13: Detailed view of the life cycle of *Obelia*

Metagenesis

The life cycle of *Obelia* represents a remarkable example of alternation of generation where the asexual and sessile phase of *Obelia* reproduces asexually by budding and gives rise to sexual and free-swimming medusa. The medusa reproduces sexually and forms new polyps. Thus, a diploid asexual hydroid phase alternates with another diploid sexual medusoid phase. This phenomenon of alternation between two diploid phases is termed as **metagenesis**.

Polymorphism

Thus, the life cycle of *Obelia* includes three distinct types of zooids;

Morphology and Physiology of *Obelia*

a) Nutritive polyps – hydranths
b) Asexual reproductive polyps – blastostyles
c) Sexual reproductive polyps – medusa

This phenomenon, where *Obelia* is represented by structurally and functionally different individuals, is called **polymorphism**. Initially the colony of *Obelia* is represented by only two forms, gastrozooids and blastozooids and is called **dimorphic**. Later, when gonophores develop on the blastozooids by the process of budding, the colony is considered **trimorphic** represented by three kinds of zooids.