BHARATHIDASAN UNIVERSITY
Tiruchirappalli- 620024,
Tamil Nadu, India.

Programme: M.Sc., Marine Biotechnology

Course Title : Marine Bioresources and Aquaculture

Course Code: 21 CC 4a

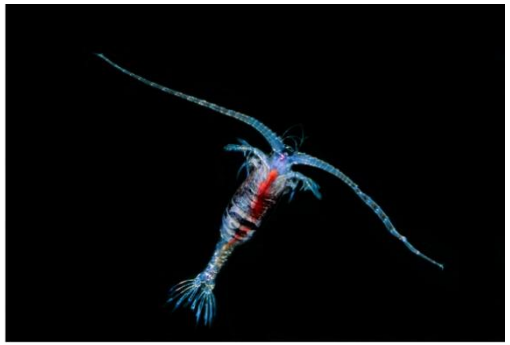
Unit-I

Important marine Organisms and their behavior

Dr. S. Rajakumar

Associate Professor

1. Zooplankton



- Zooplankton are small, aquatic microorganisms in the water column that include crustaceans, rotifers, open water insect larvae and aquatic mites. The zooplankton community is composed of both primary consumers, which eat free-floating algae, and secondary consumers, which feed on other zooplankton.
- Two general groups of zooplankton exist: those that remain planktonic throughout their entire life (holoplankton), and those that are larval stages of larger life forms (meroplankton).
- The most important types of zooplankton include the radiolarians, foraminiferans, and cnidarians, crustaceans, chordates, and molluscs.

Types of zooplanktons

Size class	Size range	Representative organisms
Microzooplankton	20 – 200 μm	Small stages of copepods, foraminifera
Mesozooplankton	0.2 – 20 mm	Amphipods, appendicularians, chaetognaths, copepods, thaliaceans (doliolids and salps)
Macrozooplankton	20 – 200 mm	Euphausiids, heteropods, jellyfish, larval fish, mysids, pteropods, solitary salps
Megazooplankton	> 200 mm	Jellyfish, Colonial salps

The most common plankton are protists, nanoplanktonic flagellates, cnidarians, ctenophores, rotifers, chaetognatha, veliger larvae, copepods, cladocera, euphausids, krill and tunicates.

Adaptations

- flat bodies, lateral spines, oil droplets, floats filled with gases, sheaths made of gel-like substances, and ion replacement.
- The flat body and spines allow some species of plankton to resist sinking by increasing the surface area of their bodies while minimizing the volume.
- All other adaptations keep plankton from sinking quickly to the bottom. Zooplankton have also adapted mechanisms to deter fish (their heaviest predator) including: transparent bodies, bright colors, bad tastes, red coloring in deeper water, and cyclomorphosis.
- Cyclomorphosis occurs when predators release chemicals in the water that signal zooplankton, such as rotifers or cladocerans, to increase their spines and protective shields.

Meroplankton and holozooplankton

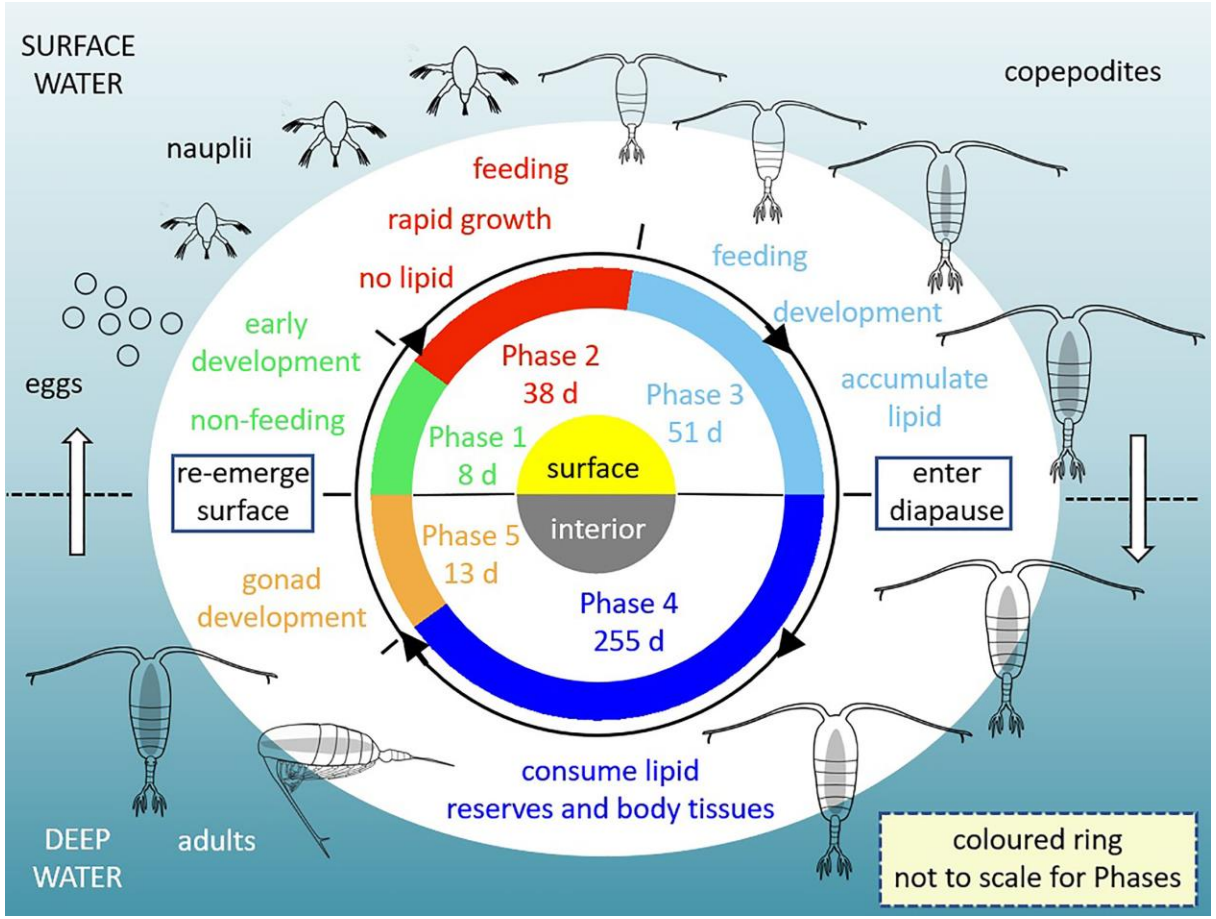
- Holoplankton, i.e. permanent members of the plankton that spend their entire lives in the water column.
- Many species in the ocean are part of the meroplankton because they have planktonic stages for dispersal, including larval and young stages of animals that will settle out to the bottom or shoreline when they mature.
- Examples of holoplankton include krill, copepods, larvaceans, some jellyfish (i.e. those without a bottom-dwelling stage) and salps.

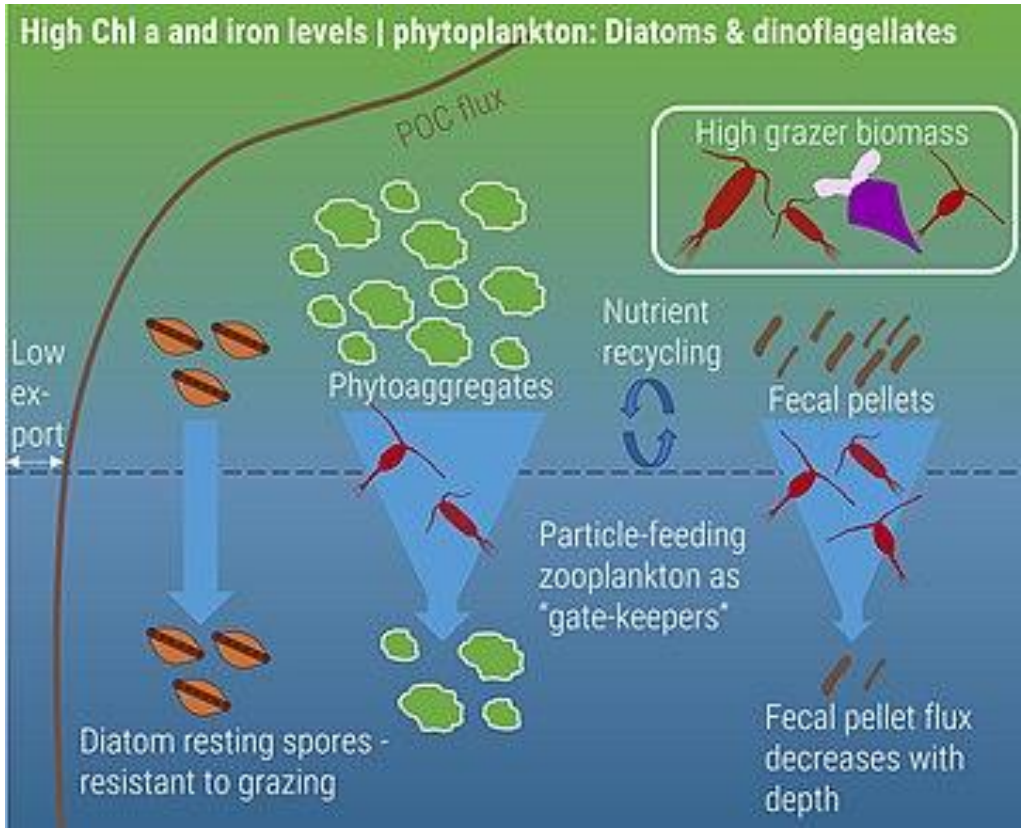
Characteristics

- They are able to live in both **fresh** and **salt water.**
- They are bad swimmers.
- It reproduces **asexually** through a process called **bipartition**.
- Juvenile fish are part of zooplankton.
- They move up and down in the water.
- They look for **water surface** during the night to get **food**.
- They stay in **deeper water** to get away from the sun during the day.
- It is classified by **size** and **stage** of **development**.

- It is made up of secondary and tertiary producers.
- **Freshwater zooplankton** consists mainly of **protozoa**, single-celled animals and some crustaceans.
- When they die, their shells fall and settle to the bottom of the sea.
- The majority is located in the **North Atlantic** and the greatest **diversity** in the **Pacific Ocean**.
- Zooplankton known as “**krill**” is whales’ favorite food and lives in cold water.
- Each species is uniquely adapted to factors like light, temperature, turbulence, and salinity in its environment

Feeding behaviors





Crustaceans

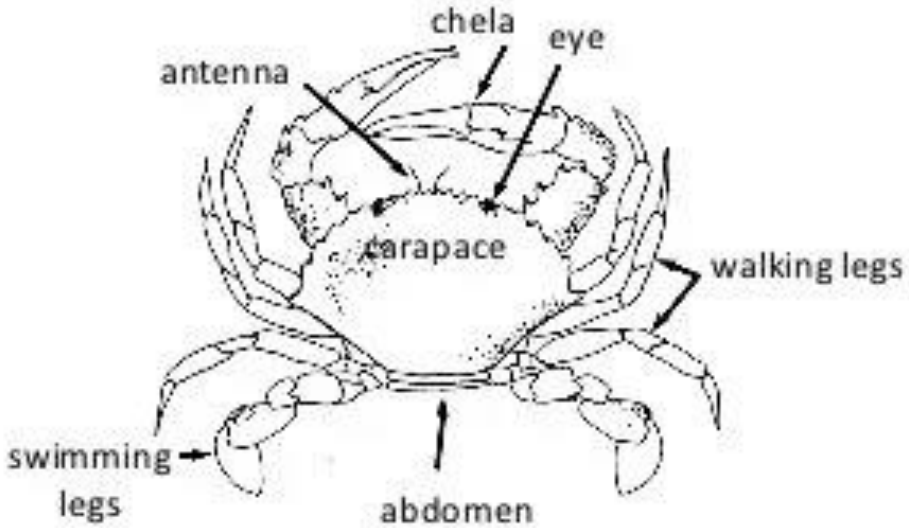
- Crustaceans are **a very diverse group of invertebrate animals which includes active animals such as the crabs, lobsters, shrimp, krill, copepods, amphipods, and more sessile creatures like barnacles**.

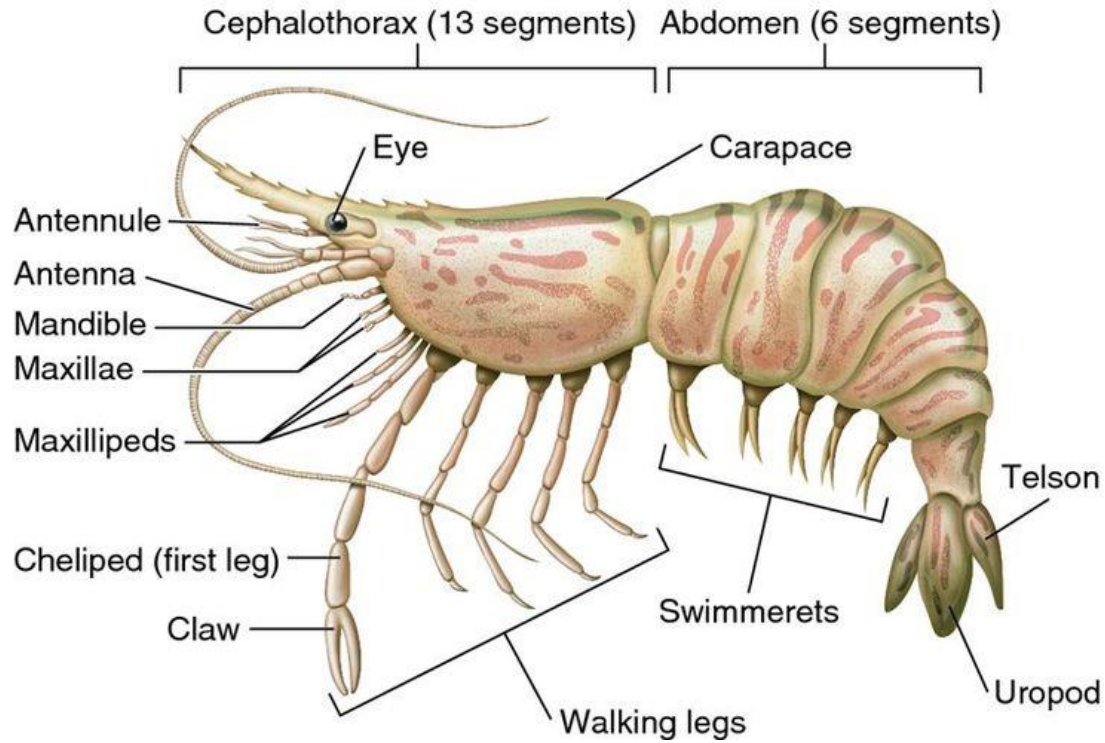
- Crustaceans are mostly found in marine environments where they are common on the sea floor, water column and in the intertidal zone.

Biology

- The body of a crustacean can be divided into the head, thorax and abdomen.
- The head bears the two sets of antennae, mandibles and maxillae (mouth parts).
- A thorax is the crustacean equivalent of a chest but it is split into numerous segments. Each segment has a pair of legs each leg is usually jointed.
- The abdomen contains the reproductive organs and is where females store their eggs. The abdomen of many species is quite muscular and is often important for swimming.
- Most commonly crustaceans have hard shells called an exoskeleton. The exoskeleton often forms a shield over the back of the head and the thorax to create one hard shell called the carapace.

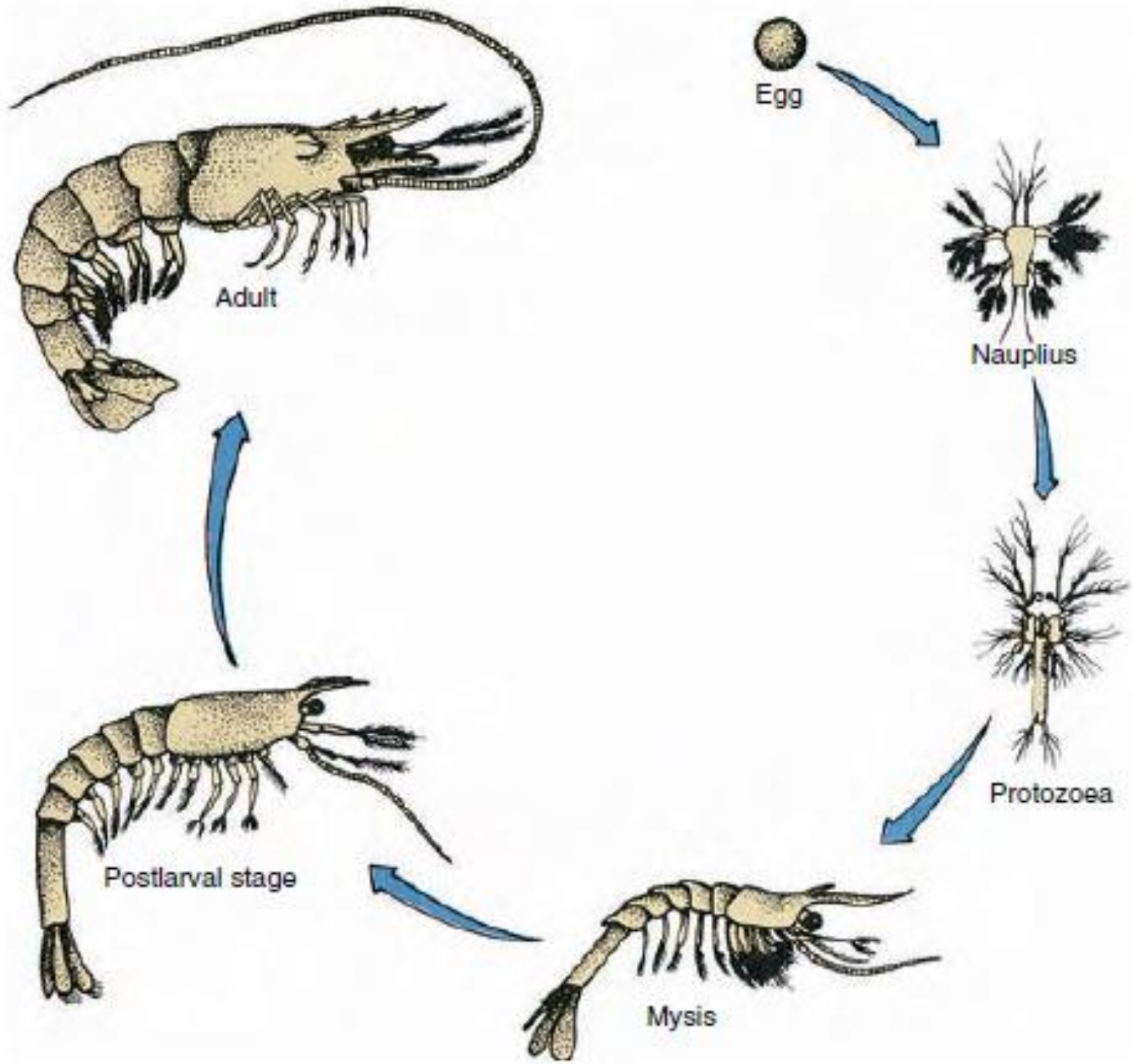
crab anatomy – dorsal view

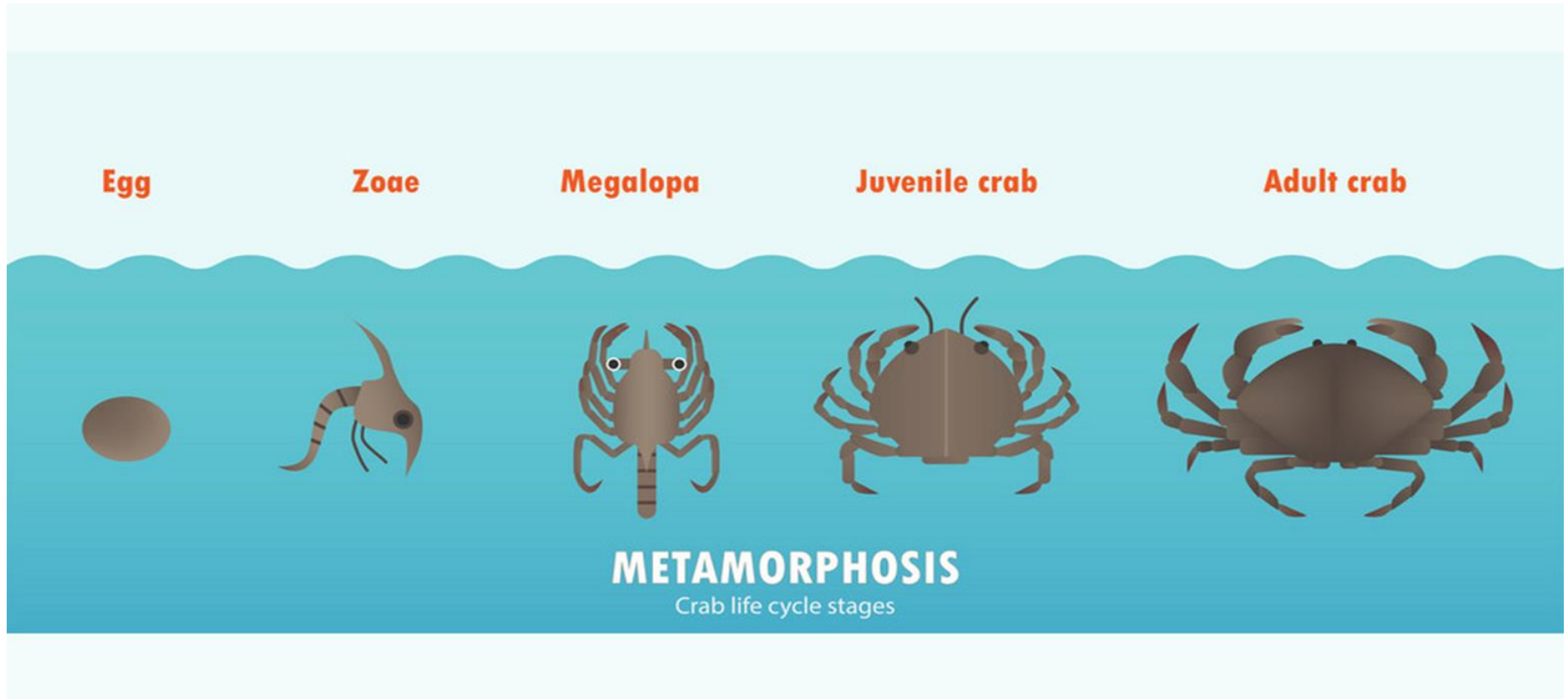




Reproduction

- Crustaceans reproduce sexually, and, in most species, male and females are separate sexes.
- there are intermediate juvenile stages called larval stages that are very different in form from the adult.
- One of the unifying features of all crustaceans is that they all develop through a larval stage called **nauplius** (plural, *nauplii*) that is unique to this group.
- A nauplius larva**.** The defining feature of nauplii is that they use appendages attached to the head as swimming appendages.
- These appendages change considerably as they develop into the antennae of the adult crustacean.
- This is characteristic of indirect development; the transition from larvae to adults usually involves a fairly drastic change in form called metamorphosis.


Egg
Nauplius
Protozoea
Mysis
Postlarval stage
Adult


Egg
Zoae
Megalopa
Juvenile crab
Adult crab
METAMORPHOSIS
Crab life cycle stages

Diet

- Crustaceans are omnivores.
- Although some species eat algae.
- Others like crabs and lobsters are predators and scavengers of other animals.
- Feeding on those that are already dead.
- Some, like barnacles, remain in place and filter plankton from the water.
- Some crustaceans eat their own species, newly molted individuals, and young or injured members. Some even change their diets as they mature.

Feeding

- The simplest of these are those species that practice filter feeding such as the copepods and tiny shrimps. Feeding largely on **plankton** and suspended materials
- the **animal** creates a mini **water** current towards the mouth by the rhythmic beating of countless number of fine setae that cover the specialized feeding limbs of these species.
- Food particles are collected in special filters and then transferred to the mouth.
- Larger species such as crabs and lobsters are active hunters of small **fish** and other organisms, while some species adopt a scavenging role, feeding on dead animals or plants and other waste materials.

Mollusca


Slug
Cuttlefish
Oyster
Squid
Limpet
Snail
Scallop
Mussel
Octopus
Nautilus
Clam
Winkle

Characteristics

- They are mostly found in marine and freshwater. Very few are terrestrial and found in moist soil.
- They exhibit organ system level of organization.
- Their body has a cavity.
- The body is divided into head, visceral mass, muscular foot and mantle.
- The head comprises of tentacles and compound eyes.
- The body is covered by a calcareous shell.
- The muscular foot helps in locomotion.

Con.

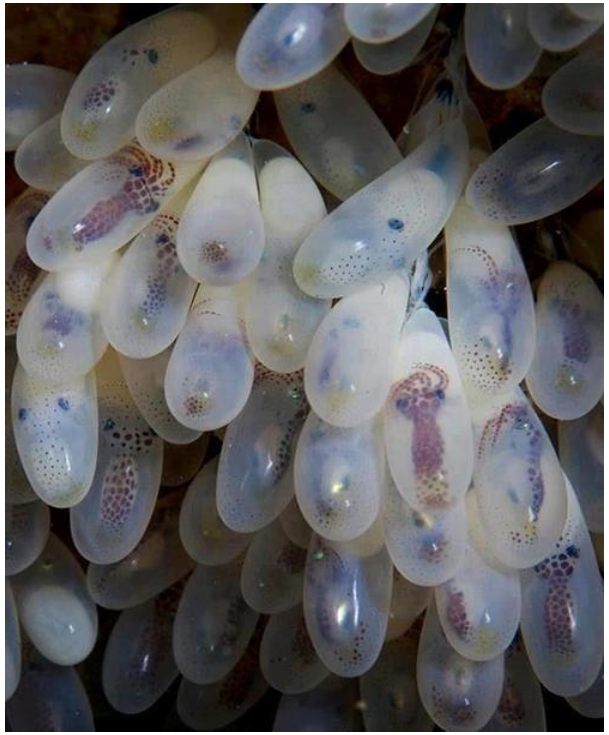
- They have a well-developed digestive system, the radula is the rasping organ for feeding.
- They respire through the general body surface, gills or pulmonary sac.
- The blood circulates through the open circulatory system.
- They have a pair of metanephridia that helps in excretion.
- The nervous system consists of number of paired ganglia and nerves.
- The tentacles, eyes, osphradium, and statocysts act as the sensory organs.
- The sexes are separate in most of the molluscs but some species are hermaphrodites. Fertilization may be external or internal.
- They are generally oviparous with indirect development.

Feeding

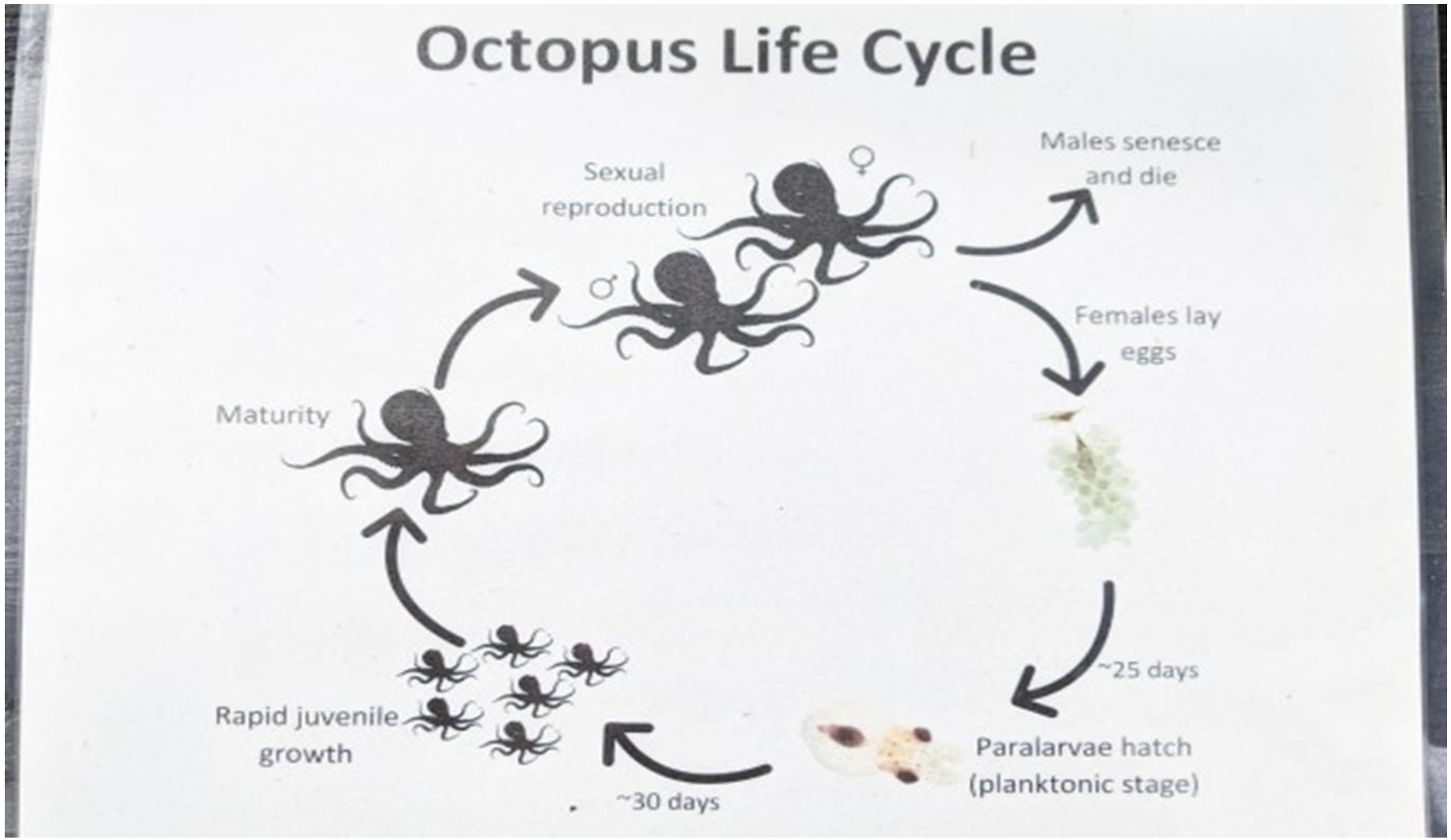
- Depending upon the species and taking their habitat into consideration, they can be plant-eaters, meat-eaters, and even omnivorous.
- Most mollusks from the phylum Bivalvia are known to be suspension-feeders.
- their diet consisting mainly of **plankton from the water column**,
- protists from the near-bottom water layer
- and deposit-feeders collecting food from the surface of bottom sediments.
- This species of mollusks is primarily represented by cuttlefish, squid, octopus, and nautilus.
- They are equipped with long tentacles, which is used for catching prey.

Reproduction

- Mollusks are primarily of separate sexes, and the reproductive organs (gonads) are simple.
- Reproduction via an unfertilized gamete (parthenogenesis) is also found among gastropods of the subclass Prosobranchia.
- Most reproduction, however, is by sexual means.
- Eggs and sperm are released into the water by members of some (primitive) species, and fertilization occurs there
- Eggs are deposited singly or in groups, generally on some hard surface and often within jelly masses or leathery capsules.



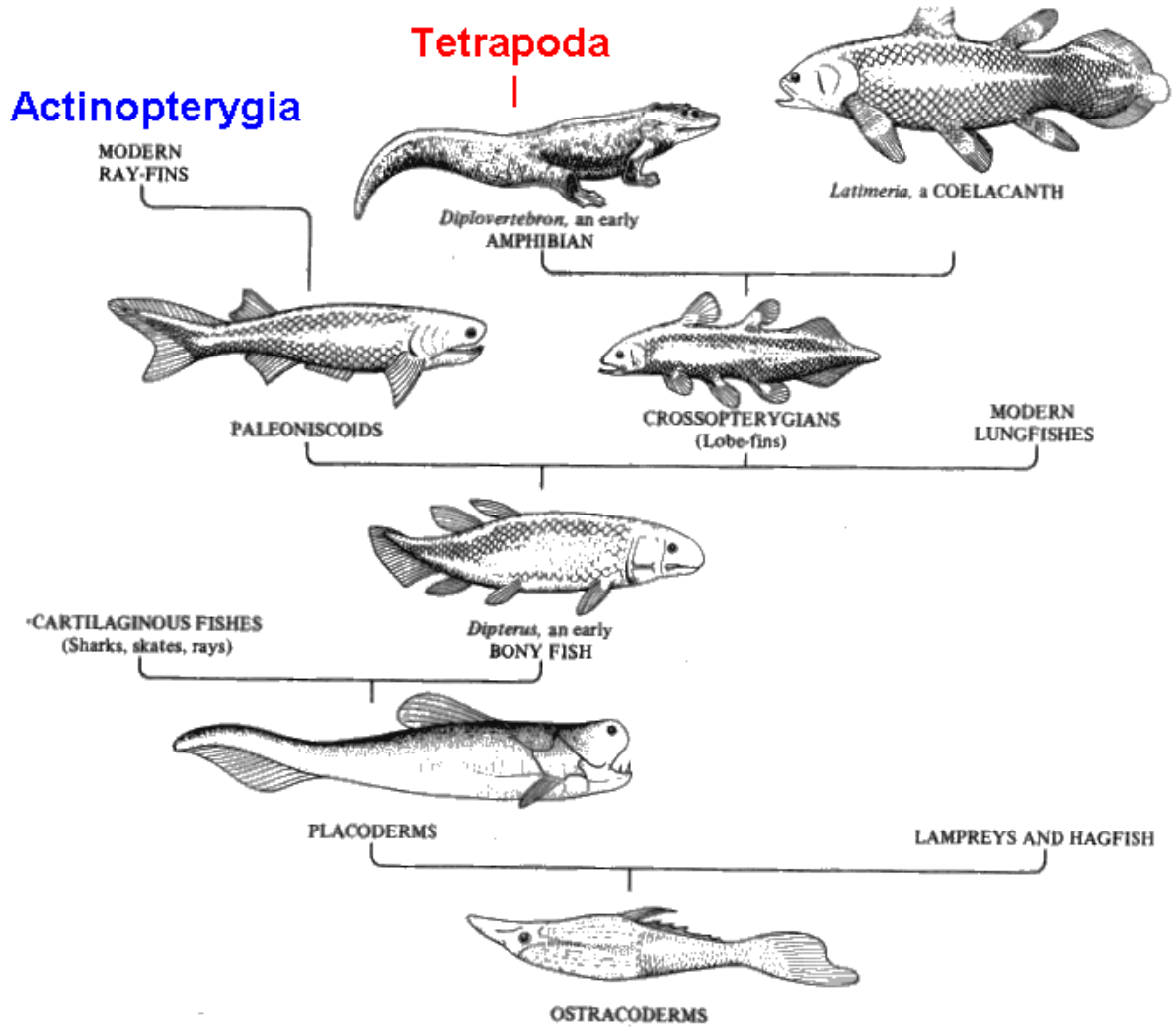
Octopus Life Cycle

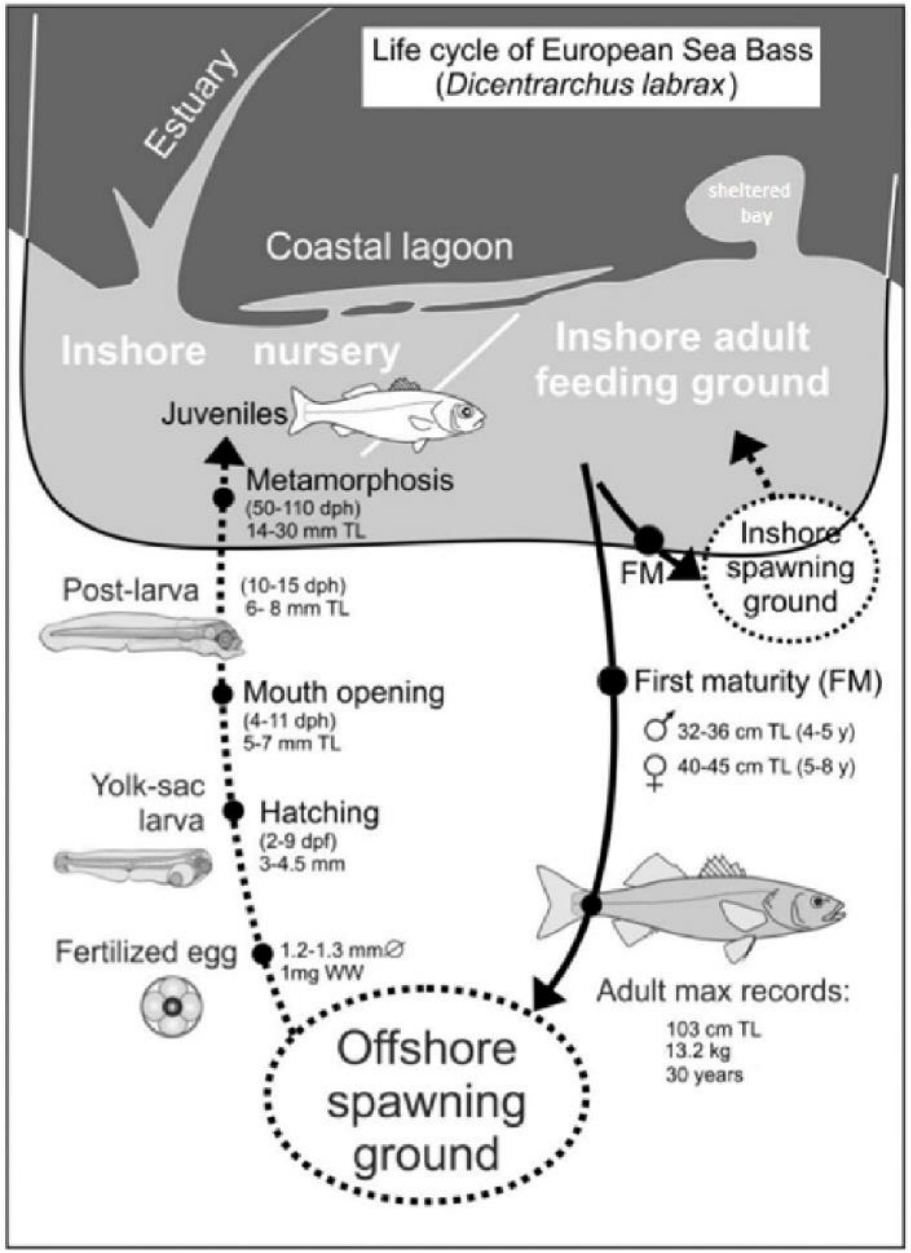


Pisces- Fishes

- Fish are aquatic vertebrates.
- They usually have gills, paired fins, a long body covered with scales, and tend to be cold-blooded. “Fish” is a term used to refer to lampreys, **sharks**, coelacanths, and ray-finned fishes, but is not a taxonomic group, which is a clade or group containing a common ancestor and all its descendants.
- Instead, there are 3 main classes, groups, or types of fish: bony fish (Osteichthyes), jawless fish (Agnatha), and cartilaginous fish (Chondrichthyes)

Life cycle


Tetrapoda
Actinopterygia
MODERN RAY-FINS
Diplovertebron, an early AMPHIBIAN
Latimeria, a COELACANTH
PALEONISCOIDS
CROSSOPTERYGIANS (Lobe-fins)
MODERN LUNGFISHES
Dipterus, an early BONY FISH
CARTILAGINOUS FISHES (Sharks, skates, rays)
PLACODERMS
LAMPREYS AND HAGFISH
OSTRACODERMS


Life cycle of European Sea Bass (Dicentrarchus labrax)
Estuary
Coastal lagoon
sheltered bay
Inshore nursery
Inshore adult feeding ground
Juveniles
Metamorphosis
(50-110 dph)
14-30 mm TL
Post-larva
(10-15 dph)
6- 8 mm TL
Mouth opening
(4-11 dph)
5-7 mm TL
Yolk-sac larva
Hatching
(2-9 dpf)
3-4.5 mm
Fertilized egg
1.2-1.3 mm∅
1mg WW
FM
Inshore spawning ground
First maturity (FM)
♂ 32-36 cm TL (4-5 y)
♀ 40-45 cm TL (5-8 y)
Adult max records:
103 cm TL
13.2 kg
30 years
Offshore spawning ground

- Each fish species has a unique reproductive strategy and favors certain habitats for spawning and for early development of their newly hatched young.

•**Eggs:** Fertilized eggs develop into fish. Most eggs do not survive to maturity even under the best conditions. Threats to eggs include changes in water temperature and oxygen levels, flooding or sedimentation, predators and disease.
•**Larval:** Larval fish live off a yolk sac attached to their bodies. When the yolk sac is fully absorbed, the young fish are called fry.
•**Fry:** Fry are ready to start eating on their own. Fry undergo several more developmental stages, which vary by species, as they mature into adults. Young fish are generally considered fry during their first few months (during their first few months to just less than one year in some species).
•**Juvenile:** The time fish spend developing from fry into reproductively mature adults varies among species. Most fish do not survive to become adults. Threats to survival include fluctuations in water temperature, changes in oxygen levels, competition for habitat and predators.
•**Adult:** When fish are able to reproduce, they are considered adults. The time it takes to reach maturity varies among species and individual fish. Fish with shorter life spans reach maturity faster. For example, female round gobies mature in approximately one year and live for two to three years. Lake sturgeon can live from 80-150 years, but females don’t reach maturity until they are approximately 25 years old.
•**Spawning:** Female fish release eggs into the water (either into the water column or into a nest) and male fish fertilize eggs by releasing milt. Not all eggs are fertilized. Some fish spawn each year after reaching maturity, others spawn at intervals (every four years, for example), while others spawn only once and then die.

Phylogeny of Jawless Fishes/Agnatha

- According to fossil records, ancient primitive jawless vertebrates were found at the Ordovician rock level who lived in the Devonian period.
- These small fish-like creatures were able to live and swim in freshwater. These are collectively called Ostracoderms.
- Ostracoderm developed in the Ordovician, Silurian, and Devonian eras.
- They belong to the class Ostracodermi.

1.The body was dorso-ventrally flattened with a heavily armored head.

2.These were relatively small in size. The length ranged from a few centimeters to 18 centimeters.

- The large head had a gill chambers.
- Paired eyes and a single nostril existed.
- They had jawless sucking type mouth.
- There were no axial skeletons.
- The scales and bones were well formed.
- The paired eyes were located at the top of the head.

Living lampreys and hagfish together are called cyclostomes (Cyclos = round, + Stroma = mouth). The cyclostome represents the primitive living craniates.

Phylogeny of Jawed Fishes

- The jawed fish can be divided into two groups according to the evolutionary trend, namely-
    - (1) Placoderms and (2) Living Jawed Fishes.
- Living jawed fish are further divided into two main groups, namely
    - (a) Chondrichthyes and (b) Osteichthyes.
- Fishes are a large group of marine animals that lack limbs with digits, rather they have fins. They have gills in place of lungs to breathe deep inside the water. They have either a cartilaginous or body structure. Most of the fishes are ectothermic which allows them to change their body temperatures according to their surroundings. Most of the fishes have jaws with varied structures that enable them to have varied food. There are some jawless fishes like lamprey and hagfish.

KINGDOM ANIMALIA

PHYLUM Chordata

SUPERCLASS Agnatha

Class Myxini (1 order)

Class Cephalaspidomorphi (1 order)

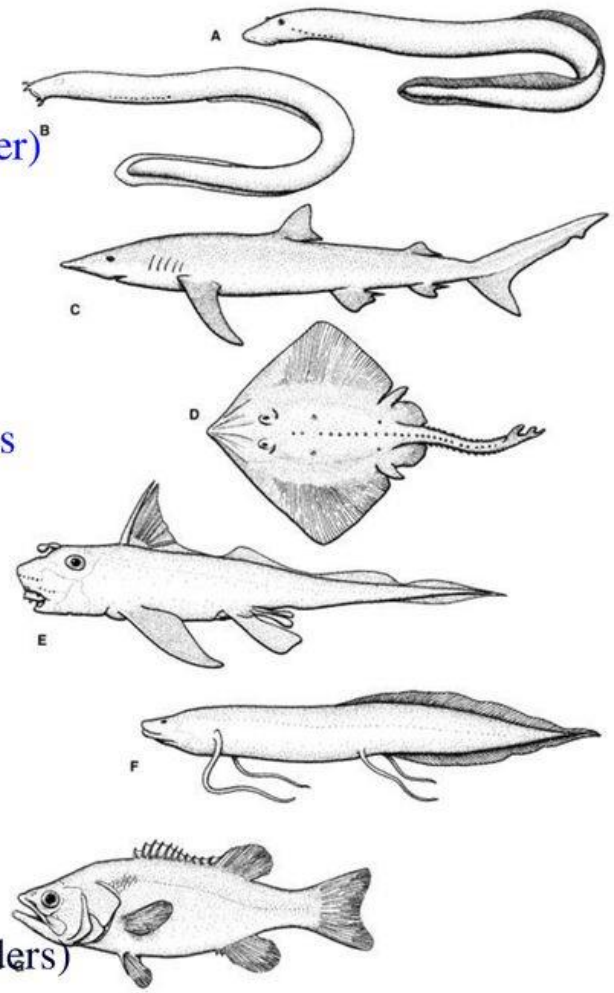
SUPERCLASS Gnathostomata

Class Chondrichthyes (10 orders)
sharks, rays, skates, chimeras

Class Sarcopterygii (3 orders)
lungfishes

Class Actinopterygii (4 orders)
ray-finned fishes

Infraclass Teleostei (35-38 orders)



- **Eggs:** Fertilized eggs develop into fish. Most eggs do not survive to maturity even under the best conditions. Threats to eggs include changes in water temperature and oxygen levels, flooding or sedimentation, predators and disease.
- **Larval:** Larval fish live off a yolk sac attached to their bodies. When the yolk sac is fully absorbed, the young fish are called fry.
- **Fry:** Fry are ready to start eating on their own. Fry undergo several more developmental stages, which vary by species, as they mature into adults. Young fish are generally considered fry during their first few months (during their first few months to just less than one year in some species).
- **Juvenile:** The time fish spend developing from fry into reproductively mature adults varies among species. Most fish do not survive to become adults. Threats to survival include fluctuations in water temperature, changes in oxygen levels, competition for habitat and predators.
- **Adult:** When fish are able to reproduce, they are considered adults. The time it takes to reach maturity varies among species and individual fish. Fish with shorter life spans reach maturity faster. For example, female round gobies mature in approximately one year and live for two to three years. Lake sturgeon can live from 80-150 years, but females don’t reach maturity until they are approximately 25 years old.
- **Spawning:** Female fish release eggs into the water (either into the water column or into a nest) and male fish fertilize eggs by releasing milt. Not all eggs are fertilized. Some fish spawn each year after reaching maturity, others spawn at intervals (every four years, for example), while others spawn only once and then die.

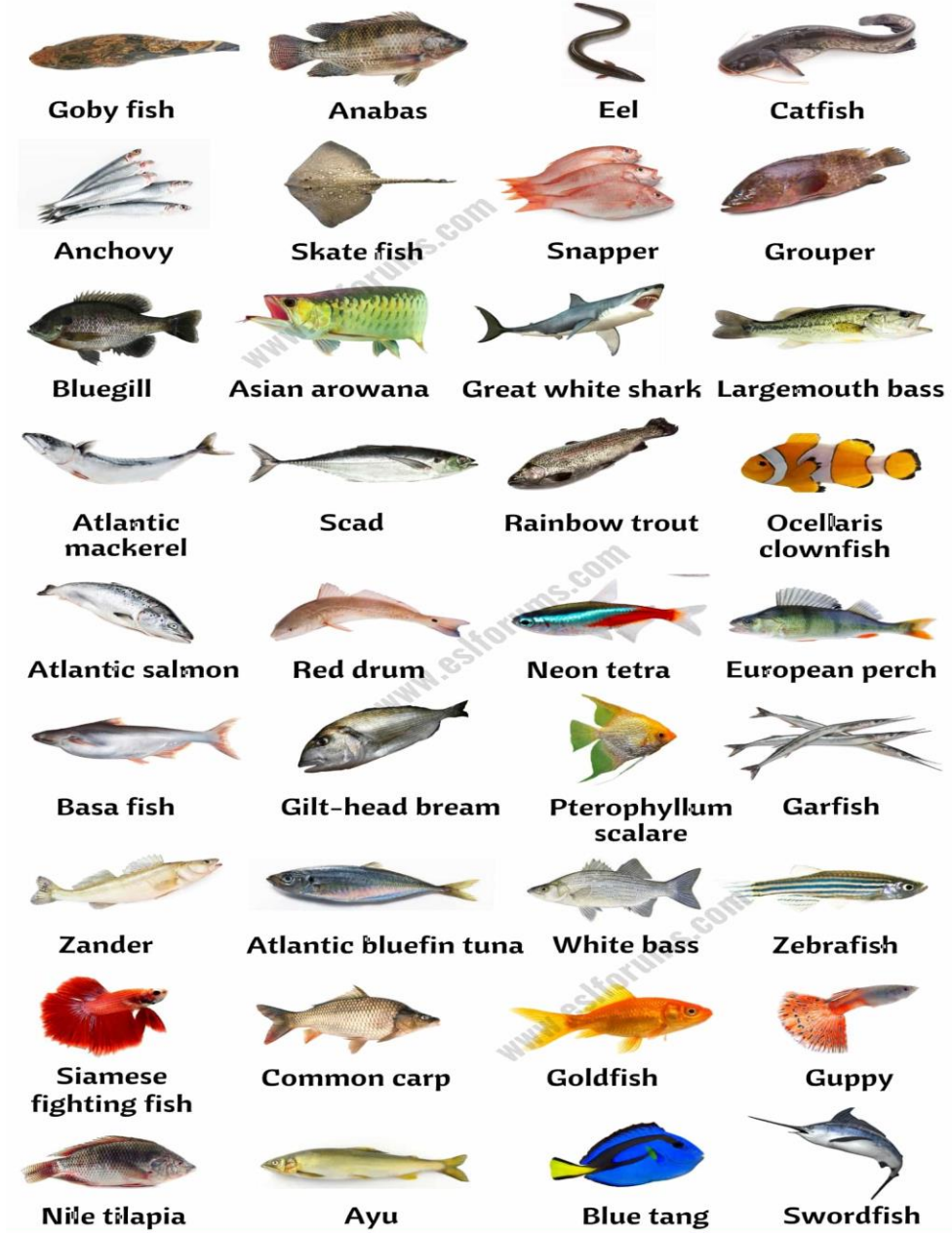
Three Classes of Fish

- **Agnatha**: jawless fish, lampreys and hagfish

- **Condrichthyes**: cartilaginous fish, sharks and rays

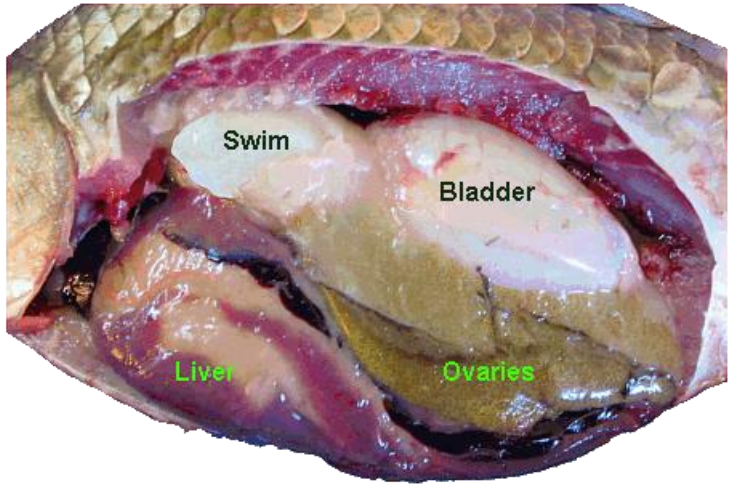
- **Osteichthyes**: bony fish

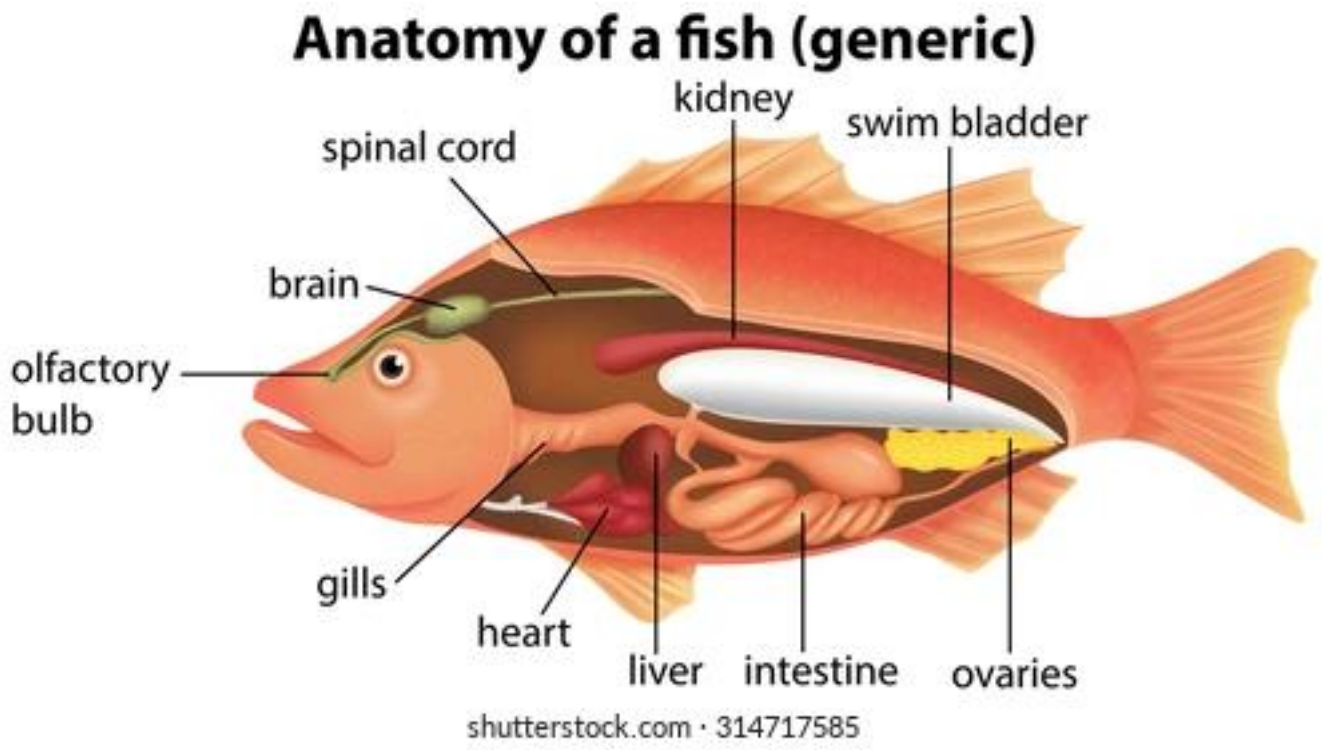
TYPES OF FISH



Characters

- Cold-bloodedness
- Water habitat
- Gills to breathe
- Swim bladders
- Fins for movement





Reproduction

- Ovoviparity has the eggs develop and hatch internally, with the young being born live. It can express either ovuliparity (external fertilization of eggs and zygote development), oviparity (internal fertilization of eggs and external development of zygotes as eggs with yolks), or ovoviviparity (internal fertilization of eggs and internal development of embryos with yolks). Stingrays, seahorses and some shark species are ovoviviparous. So are guppies, mollies, swordtails, halfbeaks and platies.
- Viviparity has embryos develop internally before being born live. It can express either histotrophic ("tissue-eating") viviparity (mother provides no nutrition and embryos eat their unborn siblings or mother's unfertilized eggs) or hemotrophic ("blood-eating) viviparity (mother provides nutrition, usually through a placenta). Many shark species are viviparous.