

8 – NEKTON AND OTHER MARINE VERTEBRATES

- Marine nekton organisms are organisms that are living in the water column, but can **actively swimming against the currents** (VS plankton)
- Some nekton can move great distances within a day (they can migrate over 100 km)
- Both vertebrates and invertebrates
- 5 most important nektonic groups:
 1. Cephalopods
 2. Fishes
 3. Mammals
 4. Seabirds
 5. Sea Turtles

1 - CEPHALOPODS

1. **Octopus**
 2. **Nautilus**
 3. **Cuttlefish**
 4. **Squid**
- Belong to the phylum of mollusk
 - **Squids** and **nautilus** → they stay in the open water
 - **Octopus** and **cuttlefish** → they are demersal, benthonic organisms, near the sea bottom
 - The cephalopods include the largest invertebrates: genus *Architeuthis*, giant squid can reach 15m
 - They have a MOUTH with POWERFUL BEAK(is hidden between the tentacles) + MANTLE (enclose water that after can be expelled very fast through the siphon that can be pointed in every direction allowed the organisms to move in any direction) + SIPHON for rapid movement + EYES very well developed + very developed and organized NERVOUS SYSTEM
 - PHOTOPHORES are cells that allow rapid color change, camouflage, deception of predatory cuttlefish (to reduce the predatory pressure)
 - Squids and octopus have an INK GLAND to produce BLACK INK to confuses predators and allow them to escape
 - Carnivores (they eat smaller fish, larger zooplankton, crustaceans) and the prey are *cached with the arms and suckers* → **the number of arms and suckers change depending on the species**:
 1. OCTOPUS= 8 arms with a lot of suckers along all the length of the arms
 2. SQUID= almost 10 with a lot of suckers
 3. NAUTILUS= many arms (more than 5) without suckers
 - Reproduction by transfer of **spermatophore** (the sperm is not free, but is contained in a sac, a specific structure that are transported from male to female, is not a spawning, but is an **internal fertilization**. There are specific tentacle that are used as sperm transporter
 - After the internal fertilization they create **eggs** (white, oval) that are usually attached to a substratum or sometimes for some species they are free floating
 - In particular squid, nautilus and cuttlefish has neutral buoyancy to control the depth, they have specialized bones in which they produce and absorb gas → they **are able to produce gas and absorb it to regulate their depth (buoyancy)**. They don't have the natatory apparatus such as the fish, but have specialized bones, rigid structure with which they absorbed the gas
 - E.g. if we look the internal structure of the shell of the *Nautilus*, we can see that it is composed by **many chambers** connected with some **tubes**, that are used for the transport of the **gas** and to regulate the buoyancy
 - E.g. the *Squid* has an internal **rigid chamber** with **gas** and **water** that help the animal to regulate the buoyancy
 - E.g. the *Cuttlefish* has a rigid structure call **cuttlebone** (OSSO DI SEPPIA) that is used to regulate the buoyancy and it is made by CaCO₃ (calcium carbonate, as the skeleton of corals or other zooplanktonic organisms and all the corallin algae). It is located on the dorsal and upper side of the animal within the body. Is provide by a series of lamellae that form a series of chambers which may be filled with water or gas and allow the buoyancy. Together with this there is an **Osmotic pump** within the

body of the cuttlefish (→ the osmotic pump doesn't move water, but the salt that is pumped or absorbed in order to move the water by diffusion and osmosis, e.g. removing water, the salt is actively pumped into small ampullae adjacent to the cuttlebone chambers, forcing the water to diffuse out the cuttlebone chamber) for **gas and water exchange between the rigid chambers and the external medium.**

2 - FISH

- They are obligate member of the marine communities
- They are able to occupy all the habitats, they are more or less in all the depth, we can find them in all the ecosystems (mangroves, seaweeds, seagrass, coral reefs...) → to **occupy all the ecological niches**
- There are around 20.000 species of fish
- Characterized by:
 - a spinal cord
 - an internal skeleton (can be composed by BONES or CARTILAGES)
 - a complete digestive system
 - fins to control movement (others are able to move using different fins: pectoral, dorsal, anal...)
- they can be classified in 2 main groups:

Chondrichthyes - cartilaginous fishes (100 species)

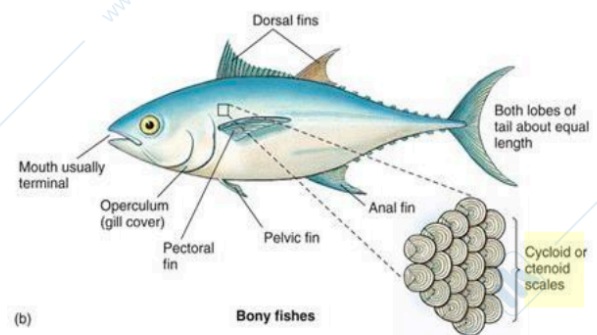
1. **Sharks**
2. **Rays**

- cartilaginous skeleton → not true bones, but is made by cartilages
- replaceable tooth rows → the teeth are organized in different rows, so once they finish to use them, the second row replace the first one
- jaw usually ventral → the mouth is not located just at the extremity of the body, but is more ventrally
- they are covered by PLACOID scales → specific structure similar to little teeth, for this reason they are not rough

Osteichthyes - bony fishes (1000 species)

They show a great biodiversity

- true bony skeleton
- much more diverse than the first group
- teeth fixed in jaws → they are not replaceable by different rows
- jaw coincides with midline → the mouth is located at the extreme part of the body, is not ventral



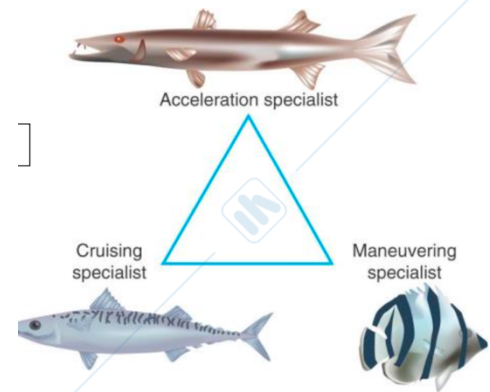
BONY FISHES

- **Bony fishes** show great diversity (not only in term of species), but also in **form, habitat, feeding adaptations, dental apparatus**
- **Form of fishes** strongly related to their:
 - Locomotion type
 - Feeding ecology

1 - Locomotion type (they are organisms)

1) Acceleration specialist

- All the fishes that show an elongated body
- With a flattened caudal region: in particular the **caudal fin** is used for the propulsion, allow them rapid moment to attack the preys or to escape from predators
- In term of feeding strategy they are lie-in-wait predator: they wait the preys, then they use the rapid movement (thanks to the caudal fin that allow a strong propulsion) to catch the them, e.g. *Barracuda*, e.g. *groupers* (stay on the bottom, inactive, but when they find a pray, they start to swim very fast) → they use this quick strategy only for short period, they don't keep a high and fast movement for a long time



2) Cruising specialist (e.g. Tuna, Swordfish (PESCE SPADA), sea bass (BRANZINO))

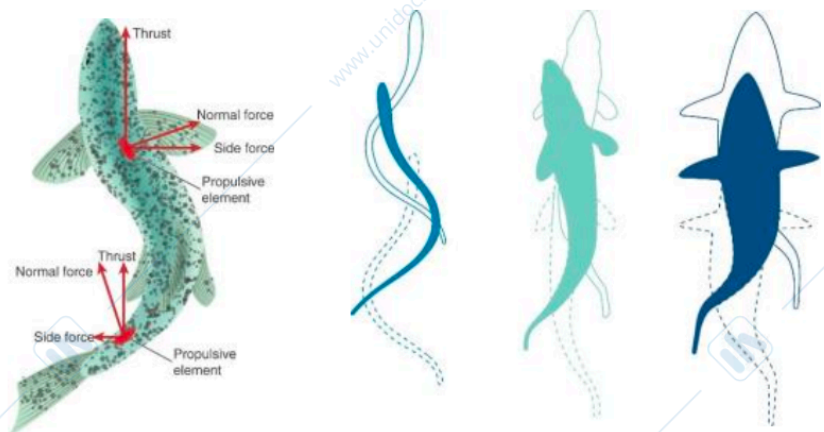
- All the fishes that are able to move very quickly, always, not only in certain moments → involve continued undulation of body, not only the undulation of the caudal fin
- They have a stiff body
- long and torpedo-shape (streamlined → very hydrodynamic shape)
- are called also rover predator because they don't wait the pray, but they catch the pray during the continuous movements, they actively go and find the pray

3) Maneuvering specialist (most of the coral reefs fish: Butterfly fish, Anglerfish, Triggerfish)

- disk/oval shape body compressed laterally, very thin body, is not so big
- oscillatory fins, they also use the pectoral fins to move together with the caudal fin
- pectoral fins extensively used in locomotion
- dorsal and anal fins extended much of the body length → they are very long

4) Swimming

- Swimming usually involves the undulation of entire body (but there are differences)
- 3 different forces: the undulation produce a **THRUST** (tangential force to the body), then there is a **SIDE** force and a **NORMAL** force that is generated by the thrust and the side forces, it excerpt the forward push → they allow the fishes to move
- There are differences in the part of body used for undulatory movements:



1. *Hill like fishes* undulate the entire body in an equal way, doing this, thanks to the 3 different forces, they move slowly
2. Other organisms don't use the entire body, but they use mostly the caudal part of the body to move, thanks to this they swim fast
3. Other species e.g. *Tuna* exclusively use the tail region to move, they are very fast organisms for a long time

- Some fish generate forward thrust by flapping of the pectoral fins (to move), instead the caudal fins are used just for the direction, in fact they are slower speeds, e.g. family *Labridae*
- They use the dorsal and the anal fins to move, e.g. *Triggerfish*, *Sunfish*, for propulsion through the water. They use the caudal fins, when are present, only for the direction

SPEED OF SWIMMING is related to 3 main factors:

- Body length and form
- Beat frequency: number of times the caudal fin sweeps back and forth in a unit of time
- Aspect ratio of the caudal fin: (**AR**) → is generated by the ration between the caudal fin height and the caudal fin area. this **INDEX** (caudal fin aspect ratio) is important to determinate the speed of swimming

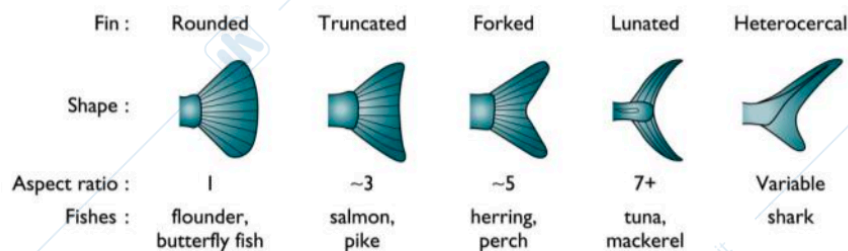
$$AR = (\text{caudal fin height})^2 / \text{caudal fin area}$$

Low AR: there is an area that is higher than the height of the caudal fin, so the tail is broad, the area is big:

- Rapid but short acceleration
- Good maneuverability (can move easily within small spaces), e.g. Butterfly fish
- The aspect ratio is close to 1

High AR: there is a little caudal fin area, the tail is narrow, but the tail is particularly height, so:

- Ideal for maintenance of high speed for a long time, e.g. Tuna, Shark...
- Bad for maneuverability



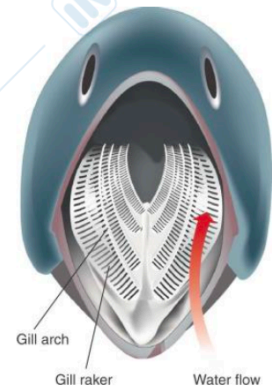
2 – Feeding ecology

3 mechanisms in water column:

- Suction:** Opening and closing the mouth, the fish create a negative pressure within the mouth which attract the organisms present in the water column, sucks both water and prey → they don't eat directly the pray, but they suck them (they also drink while they eat)
 - If they eat **LARGE PRAY**: in addition to the normal teeth they have **jaw teeth** and **pharyngeal jaws**, e.g. groupers have also 1 big tooth in the jaw, e.g. Triggerfish eat sea urchins, crabs... so they need many teeth to destroy them
 - If they eat **SMALL PRAY**: they don't have real teeth, but they have and use extension of gills (called **gill rakers**), because the gills are organized in different layers of lamellae with filaments that are used to absorb the O₂, sometimes the filaments continue outside the mouth becoming like teeth (not so resistant because are filaments, not real teeth)
 - If they eat **PLANKTON**: **finely arrayed long rakers** because aren't hard

Moray Eel (*Anguilla*) have the surprising ability to thrust the pharyngeal jaws forward in the mouth to seize pray, this animal is not dangerous because it opens and closes the mouth just to breath

2. **Ram feeders:** they are large carnivorous fish that move toward, and their open jaws encounter the prey and eat directly. The **morphology of the mouth varies extensively depending on the diet**. E.g. *Parrotfish* has the **beak** because is useful to eat the algae that stay on the rocks or stay within the corals, e.g. *Tuna*, *Triggerfish* have also **pharyngeal teeth**. E.g. the family of the *Pufferfish* is called Tetraodontidae (4 teeth: 2 in the upper and 2 in the lower jaws)
3. **Suspension feeders:** they are fishes that eat plankton drinking water and filtering the planktonic organisms. They have a particular feeding apparatus composed by GILL ARCH and GILL RAKER, called **basking** that absorb/filtrate organisms from the water. E.g. *basking shark* (they live especially in the high latitude) also called *elephant sharks* → have a series of gill arches on which gill rakers are located. Other suspension feeders are the *whale sharks* (live only in the tropical regions, they migrate and use the mouth to filter the water, but sometimes they use sucking process to eat opening and closing the mouth in order to create the negative pressure and suck water with the krill), *mantas* (2 different species: both of these have a cephalic fins close to the mouth which are used to help them in the collection of food. They are also able to move the fins in other direction, far from the mouth. In order to eat, they use the loop in order to eat much plankton as possible, the feed apparatus is directly connected with the gills apparatus)



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SENSORY PERCEPTION IN THE FISHS

- This is another characteristic that belong to these animals
- Fish adopt the **lateral line system** that detect water movement, in particular this line is clearly visible on the surface of many fishes. Is a series of mechano-receptors (in both the side of the fish) which are connected to nerves (leading to the brain) and are used to detect the presence of other fishes or to detect water movements, so it is use also for the orientation.
- Almost all fishes have **developed eyes, developed olfaction and hearing** and **Otoliths** (located close to the eyes, is a system composed by bones, hard structure which are in contact with highlike fibers). The otoliths, with the lateral line, are used for the spatial orientation into the water. In particular the pressure of the otolith against the fibers provides fish with information about its spatial orientation
- Some species, in particular ray or cartilaginous fishes have **electroreceptors** that can detect extremely small voltage and the magnetic field

Schooling

- Is a common phenomenon in fish and also in other nektonic organisms, e.g. squid
- Is a coordinated directional movement of a group of fish involving attraction of individuals as an aggregation
- This big groups of fishes are called **SCHOOLS** and they are coordinated by informations that derive from the lateral line system, and by the otoliths.
- In same case the schooling is *obligate schooler* (herring *Clupea*), instead others type of fish are *occasionally schooler* create big groups in particular situation, e.g. **to feed, to avoid to became pray** (they create confusion to the predator, so the probability to become a prey in a big group is low)
- Schools of even obligate schooling species break down in the evening, e.g. herrings
- These movements are coordinated by information received by the lateral line and visual cues
- Another explanation of why fish create this school is → Reduction of drag, **saving the energetic cost of swimming** → to reduce the energy spent to swim

In same case, herring, create very *big spherical schools* called **FISH BALLS** that minimize the peripheral area exposed to the predators, but doing this they also attract predators, in specific times of the year in the south of Africa there are the HARRING RUNS where they attract a lot of animals: attract large carnivores, that attract other carnivores, seabird, and sharks...

BODY TEMPERATURE

- Nearly all bony fishes are **poikilotherms** (temperature conformers) and their body temperature is within 1-2°C of the ambient water temperature (**body T is similar to the T of the sea**)
- **Homeothermy** (temperature regulators) occurs specially in *Scombroidei* (including tunas) and in the shark families *Lamnidae* (includes white shark) and *Alopiidae* (includes thresher shark) due to high swimming activity (**body t° greater, higher than ambient t°**)
- Elevated body temperature allows high metabolic rate and production of more power for fishes that must swim for long time at high velocity even reaching deep cold waters, as sharks...
- Heat loss reduced by countercurrent heat exchange system mechanism

Mesopelagic Fishes (live in a depth between 150-1000 m)

- They have well-developed musculature and feeding apparatus (excellent hunters because there are not so many preys, also there isn't plankton and zooplankton at that depth)
- Mainly piscivores with very big mouth (due to the rarity of prey)
- Many species simultaneous hermaphrodites: at the same time they are male and female
- Photophores on the ventral attract that provide light (create the phenomenon of **counterillumination**) for attract mates, illuminating prey, confuse predators

There are 2 main groups of mesopelagic fishes:

1. **ANGLERFISH** → has a *lure between the eyes* that is a fin ray modified by evolution into a structure that attracts other fishes thanks to the light that is produced by bacteria
2. **VIPERFISH** → has a specialized *backbone* to enable the opening of its enormous mouth (big teeth) more than 90° in order to consume large fish.

Anglerfish Reproduction

- This reproduction is something strange
- Male Anglerfish is actually pretty small
- Find a mate is a problem in this habitat, so they have developed one of the strangest method of reproduction: **the male (6mm) is very small than the female (10cm)**, the male actually lives only to find the female, upon the contact the tissue on them remain fused together, also the blood vessel join as one. The male now don't need to hunt for food because is connected with the female, so the male starts to loss everything (eyes, internal organs...) except its testes, he transfers the genetic material to the female, it fertilizes her, and she can carry up in the same time 6 male (she can reproduce every time she wants without worrying about meeting a male)

Bathypelagic and Abyssopelagic Fishes (live in a very deep zone, between 1000-6000 m)

- These fishes live in a habitat very poor of food
- In this habitat we know only 1% of the real species
- Poor musculature to reduce energy consumption
- Incompletely ossified skeleton
- The fishes are usually inactive and feed only occasionally
- Eel-like forms (e.g. snake) dominate the fish fauna of deep-sea bottoms because this shape develops a good lateral line system, which is important in a dark environment

3 - MAMMALS

There are 4 different group of marine organisms:

- Order **Cetacea**: *whales and porpoises*
- Order Carnivora, suborder **Pinnipedia**: *seals, sea lion, walruses*

- Order Carnivora, suborder Caniformia, Family **Mustelidae**: *sea otters*
- Order **Sirenia**: *sea cows, dugongs*

Cetacea

Are subdivided in 2 categories, 2 orders:

1. Suborder **Odontoceti** (toothed whales) they have teeth
2. Suborder **Mysticeti** (baleenwhales) they have not teeth, but have the balen-teeth

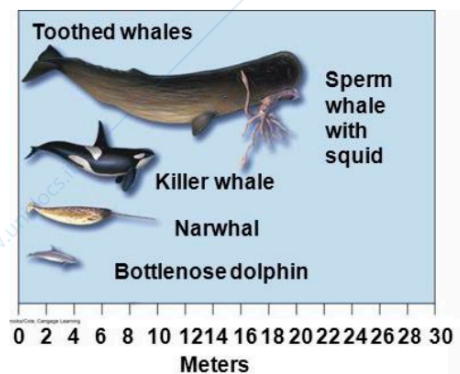
Both these 2 orders have these characteristics:

- The body is hairless, elongated and streamlined (useful to reduce drags and to be hydrodinamism)
- The forelimbs have been reduced as stabilizing paddles, instead the dorsal limbs have been completely reduced
- **The posterior ends** move up and down (not laterally) to move forward the animal (can reach also speed up to 20 miles/h)
- **They are Homeothermic** with a thick subdermal layer of fat that retards heat loss (also countercurrent exchange system in the limbs → reduce the heat loss)
- **They are Air breathers** and must return to the surface for oxygen → breath the atmospheric oxygen, in fact they go sometimes to the surface
- Nasal opening is the **blowhole** located at the back of the head and once reach the surface CO₂ is expelled and oxygen is absorbed using this nasal opening
- Reproduction: **courtship rituals** including vocalization and multiple matings over a short period, they can live crating big group
- After a gestion period of several months (also 1 year → similar to the human) the young take the mother milk that have high fat content

Suborder **Odontoceti**

1. **Bottlenose dolphin**
2. **Killer whale**
3. **Sperm whale**

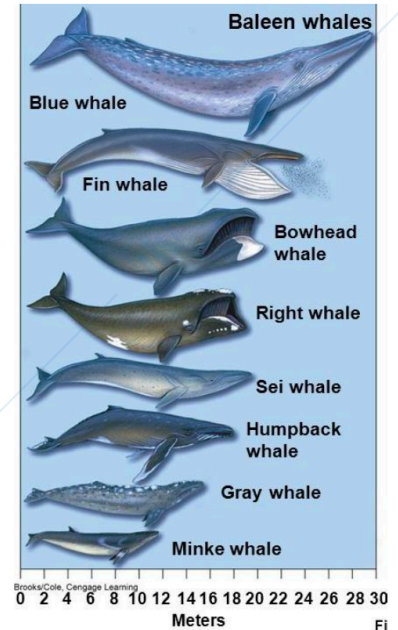
- **Toothed**, usually hunt large prey (→ they have teeth in fact they usually hunt large pray)
- From few meters lenght (dolphin) to 15-20 m (sperm whale) → smaller than other Cetacea
- They are excellent divers (one sperm whale can reach 2250 m of depth)
- 1 blowhole
- They have developed oral communication generating a series of **sonic and ultrasonic clicking signals (echolocation)**. They can also receive sonic signal with a structure → Bulbous structure (**melon**) on the anterior part of the upper skull, the melon is filled with oil: **device to focus returning sound waves (it is used for the localization and communication)**
- They are famous for the ECHOLOCAION → they can estimate the distance on the bases of the travel and retro time of the click of the signals that they produce, and they analyze thanks to the melon
- They usually live in group, that can be big or small, dominated by one or mole male or female.
- Usually the *killer whale* travel in PODS composed by 10 individual with the dominant males and several females
- Usually *bottlenose dolphins* travel in group called HERD composed by 15 individuals, each individual is specialized to perform specific function
- *Sperm whales* more in groups of 10 related females, so one big female that hunt the pray and the other females that take care of the baby, this is because the female usually are solitary



Suborder **Mysticeti**

1. **Blue whale**
2. **Humpback whale**
3. **Grey whale**

- They are distinguished by the replacement of teeth (→ they have not real teeth), they have **horny baleen plates** derived from dermal tissue, are more filamentous. The plates are attached to the upper jaw from which project sheets composed of individual long straining bristles used to capture large or fine zooplankton (es. krill or copepods) → they are zooplanktonic species, not carnivores, but eat krill or copepods
- We can distinguish 2 different types of whale:
 - **RIGHT WHALES** → feed by swimming slowly, they have more or less always open the mouth to take little zooplankton species, such as fine copepods. The baleen plates are very long and they are also called **CONTINUOUS SUSPENSION FEEDERS**
 - **RORQUAL WHALES** →, such as the blue whale, they have short baleen plates, and they periodically close the mouth, so they swim faster eating big zooplankton such as krill (small shrimps), in fact are also called **INTERMITTENT SUSPENSION FEEDERS**.
- All mysticetes have 2 blowholes, not only one
- Size: from 10-15 m (gray whale) to more than 30 m (blue whale) → bigger than the Odontoceti
- Often **migrate great distances** between feeding ground and breeding site → they can travel also covering a huge space *crossing the entire*, in particular the gray whale and the humpback whale: usually the gray whale spends summer in the northern part of Alaska, then in winter the breeding ground is located close to the Bahia California, so they migrate there.

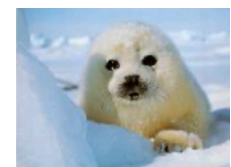
Order Carnivora, suborder **Pinnipedia**

1. **Seal**
2. **Sea lion**
3. **Elephant seal**
4. **Walruses**

- Have hair and lack the large amount of fat characteristic of whales → the hair are used to avoid the heat loss
- Rear legs are modified as **FLIPPERS**
- Size is variable: from 1 m long (sea lion) to 6 m and 4000 kg (elephant seal)
- Spend a great time out of water (are not fully marine animals), diving for prey (elephant seal also to a depth over 1500 m) → they are not fully marine animals
- **Carnivores** (eat fish) with simple teeth, sometimes the teeth are very developed, as walruses
- They have typical mating and reproductive habits on large beach and rocky-shore areas (they create **harems** of 1 male and a lot of females, so they fight for the dominance, and they can also die)

2 types of seals:

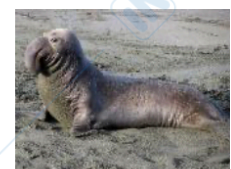
- Family of **Phocidae**: FOCHE, they're called **true seal**, haven't ears, but only small ears holes, not the flaps (Weddell seal and elephant seal), they have short thick flippers with nails used for steering



Seal



Sea lion



Elephant seal



Walrus

- Family of **Otariidae**: OTARIE they are called **eared seal**, have ears (Australian fur seal), they have long fore flippers no hair or nails

Order Carnivora, Family **Mustelidae**

1. **Sea otters** (*Enhydra lutris*)

- Most of the time they laid of the water, they swim and keeping their bottom part of the top
- Streamlined body
- They have a lot of hair that represent a thermal barrier to retard heat loss to seawater → because they live in mid high latitude, cold environments in the KELP FOREST ECOSYSTEM
- Carnivores, preying mainly on benthic species as **sea urchins**, **mollusks**, and **fishes** (diving tens of meters) → they control the amount of sea urchins feeding on them, how they eat the sea urchins? They bring the prey to the surface and often crush them with the aid of rocks to open them and eat
- Important in the structure of the kelp forest ecosystem (predation of sea urchin)
- They can produce sounds, they screams



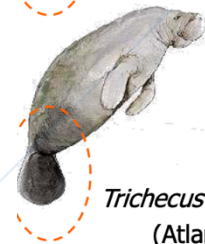
Order **Sirenia**

1. **Dugong dugong**
2. **Trichechus manatus**

- They are the main grazers of the seagrass
- They are hairless and streamlined with a big layer of fat to reduce the heat loss (Homeotherms)
- We can distinguish them because the Dugong is indo-pacific while the Manati lives in the Caribbean waters, Atlantic Sea, both in the shallow waters
- They are very big and move slow, are also called SEA CHOW because eat seaweed → **herbivorous**



Dugong dugong
(Red Sea to Australia)



Trichechus manatus
(Atlantic)

4 - SEABIRDS

- All birds that live their live mainly related to the sea: **for the reproduction and for the feeding activities**
- 4 majors groups:
 1. **Penguins**
 2. **Petrels**
 3. **Pelicans**
 4. **Gulls, Terns, Auks, Puffins**
- In general the seabirds belong to the Phylum Chordata, Class Aves
- Birds that travel some great distance across the sea and typically breed on offshore island or coastal areas
- They have **salt gland** to excrete salts gained from water and food → to maintain the internal osmolarity
- Feed on small zooplankton (pelicans) or large fish
- They are **Territorial** or **great migration** of thousands of Km between nesting and feeding area, e.g. *Albatross* is one of the bigger birds in other planet, it migrate long distance and can live for > 50 years
- Long-lived

Seabirds - Penguins

- They lost the wings, in fact they have **FLIPPERS** (modified wings)
- Live in cold Antarctic and subantarctic waters in colonies (BIG or SMALL) that vary from a few pairs to thousands
- **Adaptations to cold:**
 - Layer of blubber and feathers
 - Countercurrent heat exchange in circulation to the wings and feet
 - Nasal passage heat exchange system that retains heat during exhaling (the respiration)
 - Some species huddle in aggregations to keep warm and stay together
- Size variable (from 1 to 30kg–from 40 to >1m) the little blue penguin is big just few cm, the majestic emperor penguin is the biggest penguin ever (more than 1.5m of high)
- Small fish as food (some species depend on krill)
- They are good divers because in addition to lung (brown) they have specialized abdominal right lung sac (pink) to increase aerobic capacity
- Father penguins usually incubate the mother's single egg throughout the entire Antarctic winter → the father take care to the baby
- The baby hatches in spring and will be with the parent for more or less 1 year → then became adult



Seabirds - Petrels

1. **Snow petrels** (procellaree)
2. **Albatros**
3. **Diving petrels**
4. **Shearwaters** (verte)



Snow Petrels



Diving Petrels



Albatros



Shearwaters

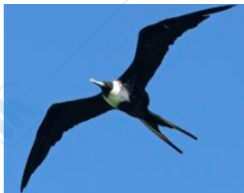
- Large external nostrils useful to smell prey and hooked bill
- Very developed pick (useful to eat penguins or big death animals)
- They have hole as nose to smell the pray
- All colonial and nest in colonies from several thousands to just a few
- Some species show long-ranging migrations (Albatross)
- Feed on small fishes or zooplankton (shearwaters)

Seabirds - Pelicans

1. **Boobies**
2. **Frigate**
3. **Gannets**
4. **Cormorants**



Boobies



Frigate



Gannets



Cormorants

- Mainly tropical, but some species can nest in the Arctic and Antarctic (high latitude)
- Most species live closer of the land (with exception of the frigates)
- Many diverse hunting methods
- Feed on small fishes

Seabirds – Gulls, Terns, Auks, Puffins



Terns



Gulls



Puffins



Auks

- *The most diverse group of seabirds*
- They are very different, there are species that live in high latitude and other that we can find everywhere (e.g. Gulls)
- Can form colonies of million individuals: they are all **colonial organisms**
- Gulls (gabbiani) extend over vast areas of Northern Hemisphere
- *Terns are more tropical*
- *Auks and Puffins are found in high latitudes*
- All feed on small fishes or zooplankton

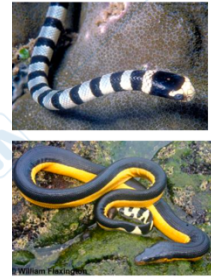
General characteristics of the sea birds:

- Most of the case they are **Monogamous** (live in pairs with the baby) and have parental care
- Often there is a **colonial breeding** that may allow sharing of information about feeding grounds and protection against predators (communal defense creating groups), but living in colony, sometimes there is competition for resources, spaces... so the territoriality and fight/combat are common in the seabirds because high quality nesting sites are in short supply in the coastal regions
- There are different mechanisms to fight: use the pick, pushing with the lags, the gulls can adopt an upright posture → usually fight is more intense for the species that nest of the cliff or in the holes where the space is very limited, where they don't live in open spaces
- **Courtship (find the mate)** occupies a great deal of time and energy, involving:
 - call: producing a strange sound
 - feeding the female: provide food to the female (a gift)
 - head-bobbing: move the head (e.g. Albatross)
 - flapping the lower mandible (e.g. Albatross)
 - occasional dance (e.g. Albatross)
 - pronounced strutting: they acquire dominance position with the chest (e.g. the penguins show the orange neck)
- 2 strategies for **hunting food**: FLYING (collect the pray that live on the surface) and UNDERWATER SWIMMING (they can reach also more than 100 m depth, e.g. the penguins, they can come from the land or from the air) → these strategies are mutually exclusive because:
 - efficient flying requires **long** and relatively **inflexible** wings
 - underwater swimming requires **short** wings usable as flippers
- Some gulls can also **feed on the land during the low tide** on seal or other organisms

5 - REPTILES

Sea Snakes

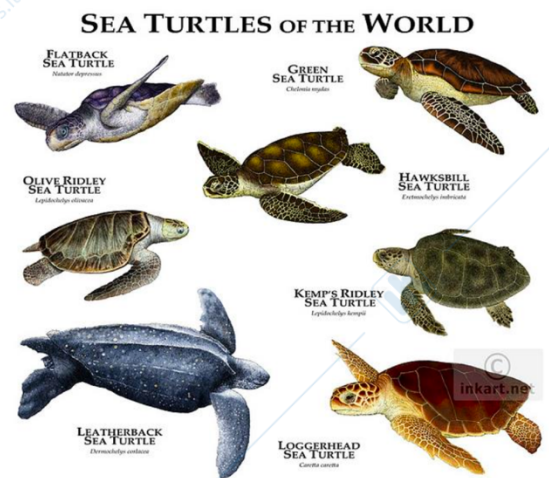
- Mainly are found in Indo-Pacific region (no in Mediterranean and Atlantic)
- They are venomous (but not deadly) → Morey Eels in the tropical ecosystem has a *Batesian mimics* to seems to the sea snakes in order to reduce the potential predator impact
- Sea snakes lay eggs on shore
- Prey upon little fish
- They must periodically go to the surface to gather air with their large lungs
- Can stay submerged for several hours



Sea Turtles

7 different groups:

1. **Green sea turtle** (consume sea Grass and seaweeds)
2. **Flatback sea turtle**
3. **Kamp ridley sea turtle** (consume benthic invertebrate)
4. **Loggerhead sea turtle** (consume benthic invertebrate)
5. **Leatherback sea turtle** (consume jelly fish and gelatinous zooplankton) → is the biggest sea turtle, maintain a very high body T, more than the ambient T and converse its thanks to the fat and the counter current heat exchange.
6. **Hawksbill sea turtle** (consume invertebrate, in particular sponges)
7. **Olive ridley sea turtle**



- Great variety of diet: jelly fish, zooplankton, invertebrates, and sponges...
- They are famous for the **BEACH NASTING** and for the **EXTENSIVE MIGRATION** → they mate near nesting beaches and females come onto shore several time per breeding season
- Each time females lay approximately 100 eggs buried in the sand during night
- After 2-month young hatch from the eggs and they are guided by 3 distinct signals:
 1. **move towards the horizon**
 2. **move opposite to the direction of arriving waves**
 3. **magnetic field provide information about migration direction**
- Long-distance migrations are common