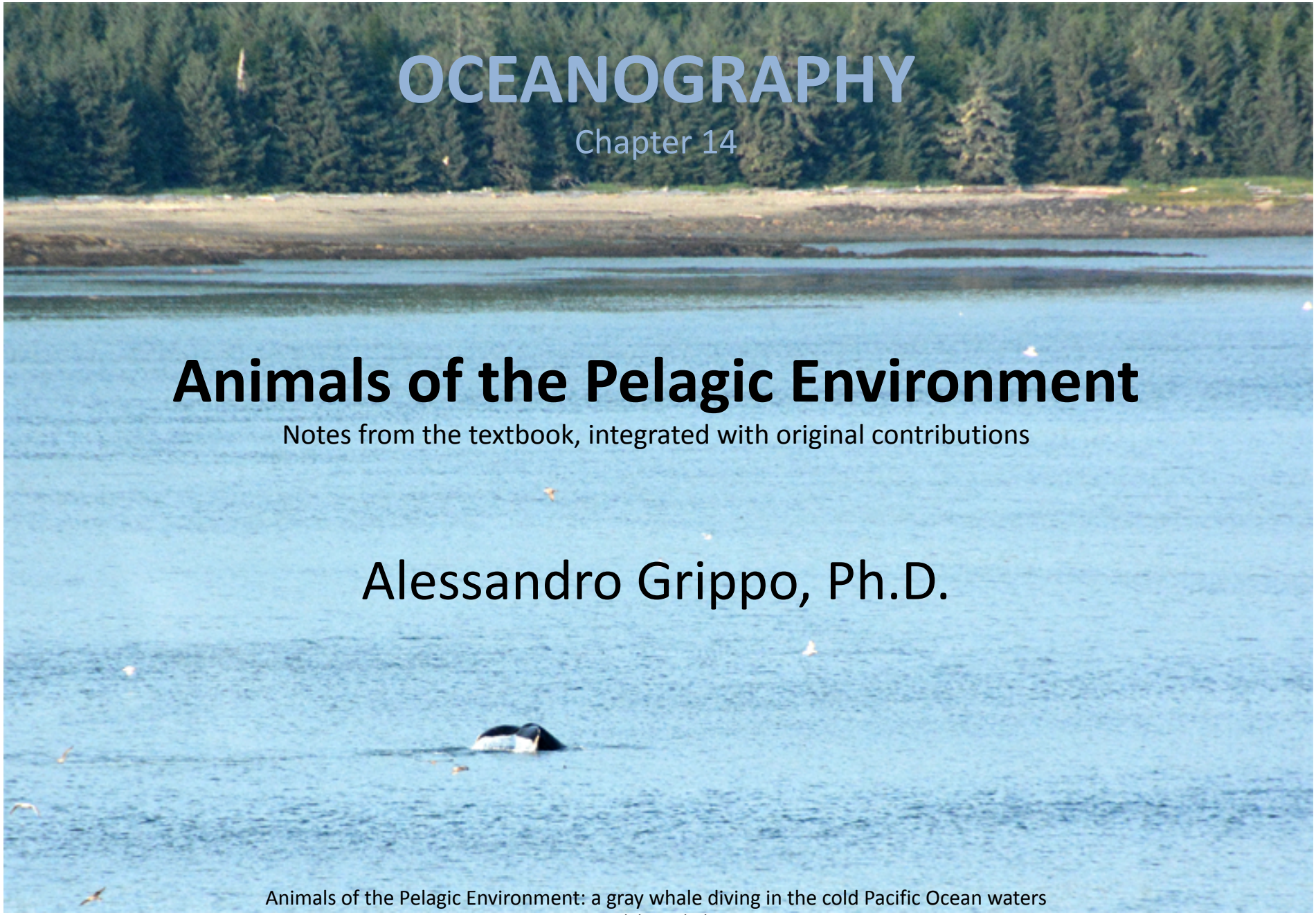
# OCEANOGRAPHY

Chapter 14

# Animals of the Pelagic Environment

Notes from the textbook, integrated with original contributions

Alessandro Grippo, Ph.D.



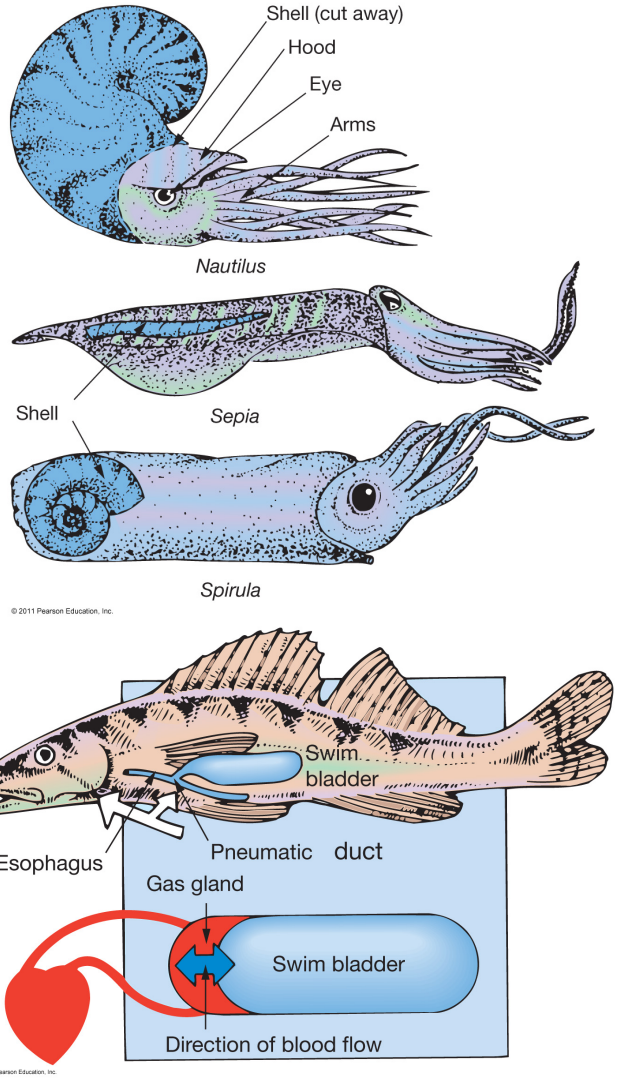
Animals of the Pelagic Environment: a gray whale diving in the cold Pacific Ocean waters
Ketchikan, Alaska

# introduction

- Pelagic organisms are those who live in the water, either floating (**plankton**) or swimming (**nekton**)
- They make for the vast majority of the ocean's **biomass**
- Because phytoplankton and photosynthetic bacteria need sunlight to survive, they need to be in the photic zone, and their predators need to be close too (the food supply is the greatest)
- One of the most important challenges for pelagic organisms is **how to avoid sinking and remain afloat**

# How Do Marine Animals Avoid Sinking?

- Some may increase their buoyancy by using gas containers
- Some are very small with delicate structures that allows them to be less dense than the ocean water
- Some release fats or oils
- Some swim



# How Do Marine Animals Avoid Sinking?

- **Gas containers** are used by some organisms to regulate how much gas they need to float, or even move upward or downward

- These containers can be either:
  - Rigid gas containers
    - *Nautilus, Sepia, Spirula*
  - Swim bladders (soft gas containers)
    - Slow moving fish
    - With depth, oxygen leaves tissues and goes into swim bladder
    - At great depth, pressure compresses the gases within the bladder to densities similar to that of fat, and close to ocean water

# How Do Marine Animals Avoid Sinking?

Animals of the Pelagic Environment: Early Triassic Ammonites (around 248 million years ago)

Ammonites are extinct cephalopods related to present-day *Nautilus.*

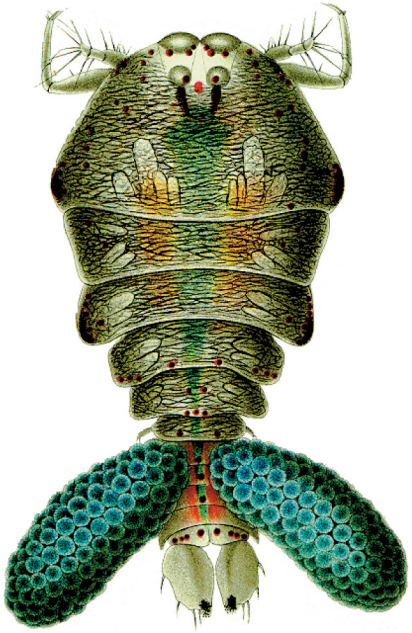
You can see some of the chambers in the coiled shells (rigid gas containers), now filled or destroyed by the growth of calcite

Union Wash, Lone Pine, California

# How Do Marine Animals Avoid Sinking?

- Ability to Float
  - Many marine animals (zooplankton, “floating animals”) are very small but some, like jellies, are macroscopic
    - Microscopic: Radiolarians, Foraminifers, Copepods
      - We studied the first two when we described sediments in the ocean
    - Macroscopic: Krill, Cnidarians, Hydrozoans, Scyphozoans
  - Many have adaptations that let them float in ocean water, such as ornamentations, soft bodies, capability to release fats and oils to decrease their density

# Copepods



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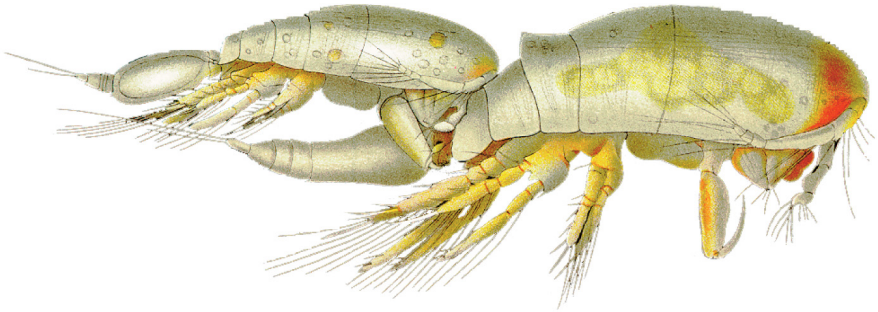

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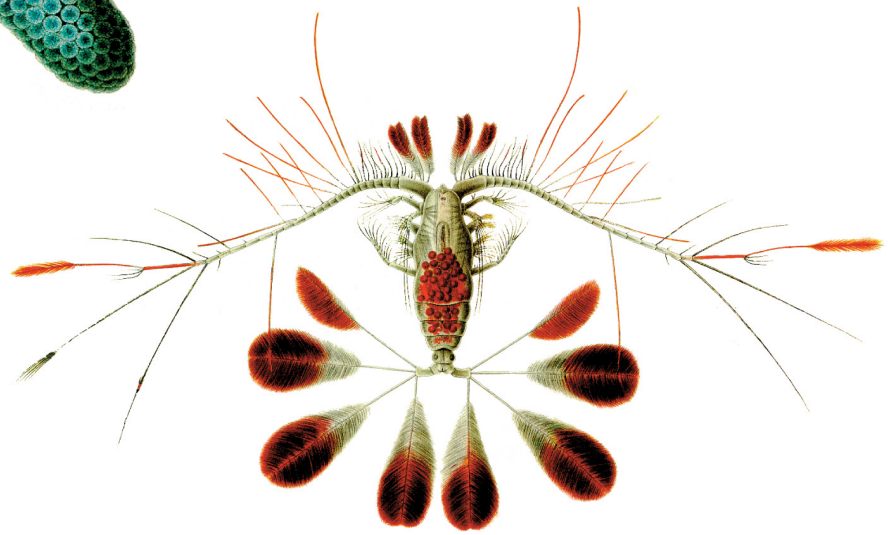


(c)



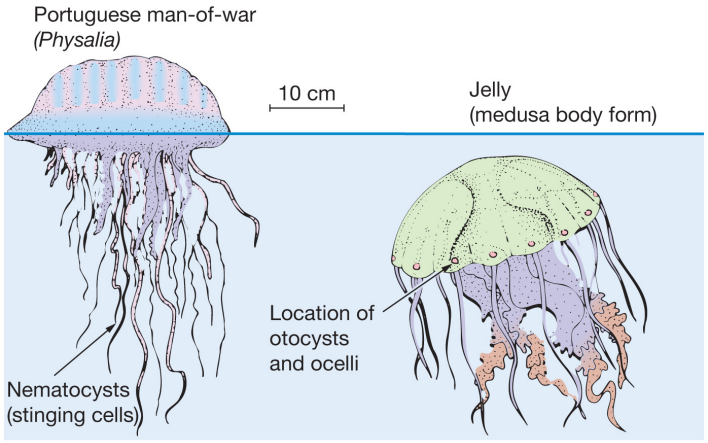
Fig. 14.5 a, b, c page 458 in your textbook

# Macroscopic Zooplankton

- Krill
  - Resemble mini shrimp or large copepods
  - Abundant near Antarctica
  - Critical in Antarctic food chains

# Floating Macroscopic Zooplankton

- Cnidarians
  - Hydrozoans (Portuguese man-of-war)
    - gas-filled float
  - Scyphozoan (jellyfish)
    - Soft, low-density bodies

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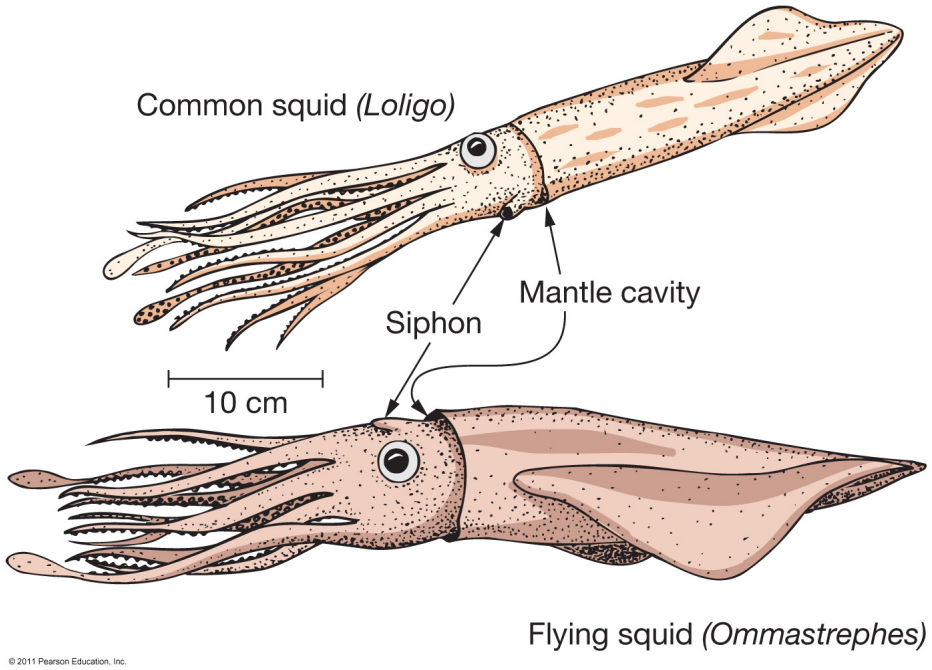
# How Do Marine Animals Avoid Sinking?

- Ability to Swim
  - Many larger pelagic organisms are able to keep their position in the water column* by swimming
  - These organisms are called **nekton**
  - Nektonic forms can swim over a wide range and undertake long migrations

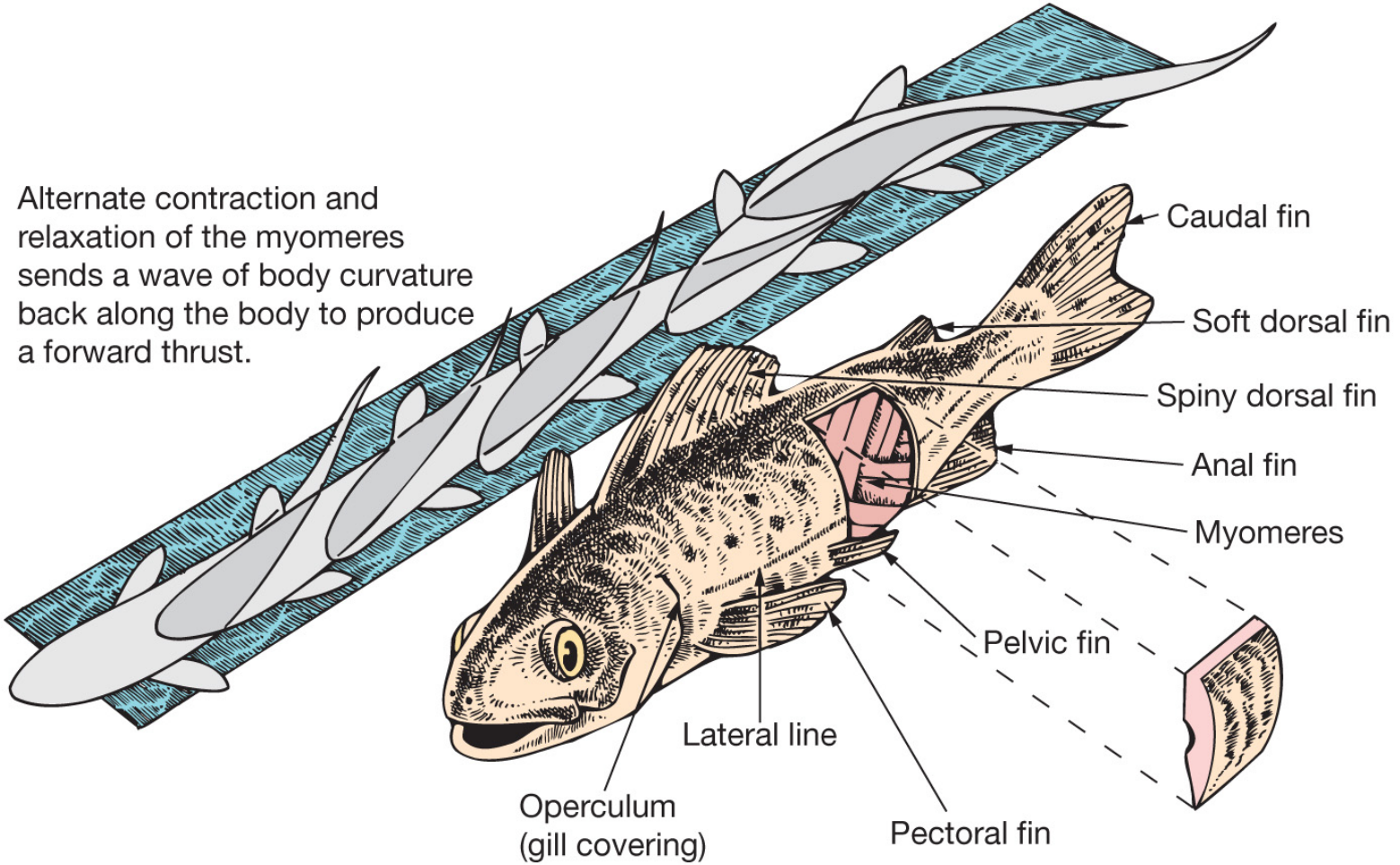
  - *The water column is a concept used in oceanography to describe the physical (temperature, salinity, light penetration) and chemical (pH, dissolved oxygen, nutrient salts) characteristics of seawater at different depths for a defined geographical point

# Swimming Organisms

- Fish, squids, sea turtles, marine mammals
- Swim by trapping water and expelling it, e.g., some squid
- Swim by curving body from front to back

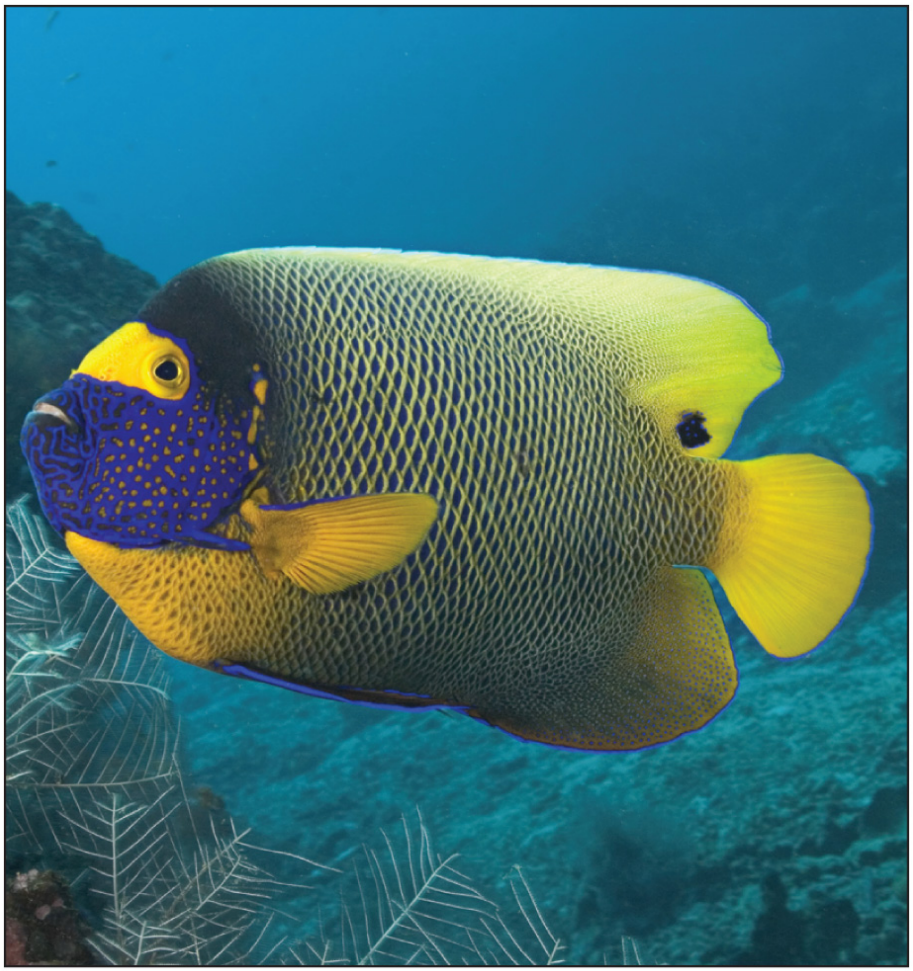


# Swimming Motion and General Fish Features



# Fin Designs in Fish

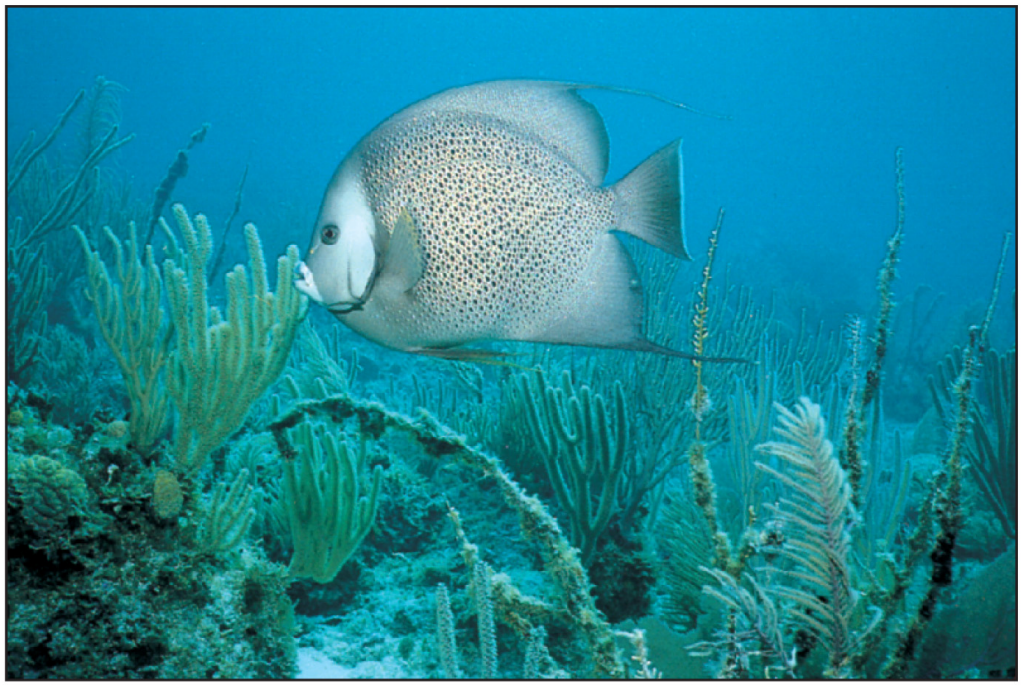
- Paired vertical fins as stabilizers
- Paired pelvic fins and pectoral fins for “steering” and balance
- Tail fin (caudal) for thrust



(a)

# Fin Designs in Fish

- Rounded caudal fins
  - Flexible
  - Maneuver at slow speeds
- Truncate fins and forke fins
  - Useful for both maneuvering and thrus



(b)

# Fin Designs in Fish

- Lunate fins
  - Rigid, little maneuverability
  - Efficient propulsion for fast swimmers
- Heterocercal fins
  - Asymmetrical,
  - Lift for buoyancy (shar

(d)

# Adaptations for Finding Prey

- Adaptation that enhance the ability of pelagic organisms to seek and capture food include:
  - Mobility
    - Lunging: Lungers wait for prey and pounce (grouper).
      - Mainly white muscle tissue
    - Cruising: Cruisers actively seek prey (tuna).
      - Mostly red muscle tissue
  - Swimming speed
  - Body temperature
  - Unique circulatory systems
  - Systems to work in the dark (deep-water nekton only)

# Lungers and Cruisers

(a)



(b)

# Adaptations for Finding Prey

- Swimming speed
- Speed generally proportional to size
- Can move very fast for short time (mainly to avoid predation)

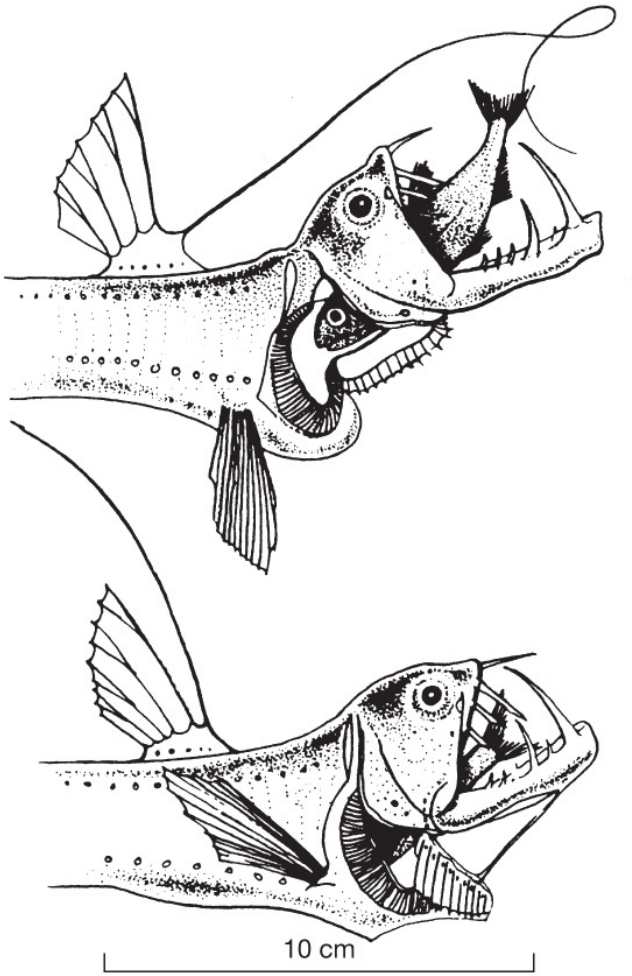
# Cold-Blooded vs. Warm-Blooded

- Most fish are cold-blooded – poikilothermic
  - Bodies same temperature as environment
  - Not fast swimmers
- Some are warm-blooded – homeothermic
  - Found in warmer environments
  - Helps them capture prey

# Adaptations of Deep-Water Nekton

- Mainly fish that consume detritus or each other
- Lack of abundant food
- Bioluminescence
  - photophores
- Large, sensitive eyes
- Large sharp teeth
- Expandable bodies
- Hinged jaws
- Counter illumination

# Deep Sea Nekton

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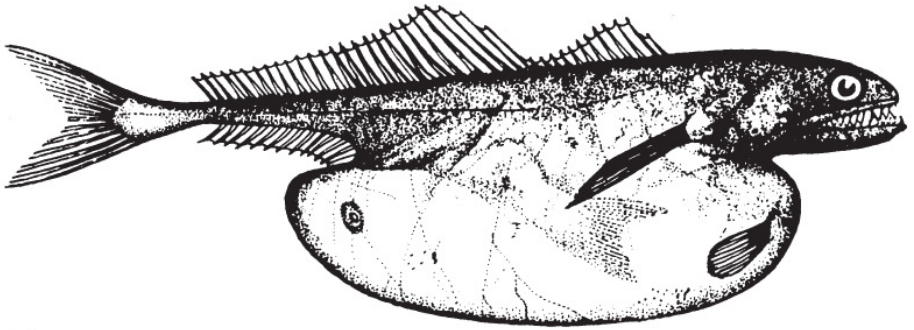
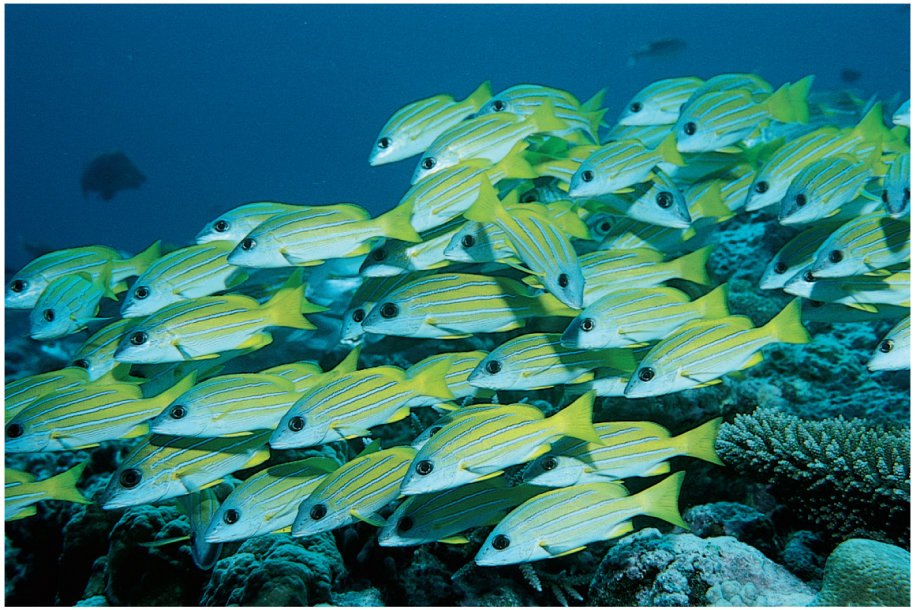


(b)

# Adaptations to Avoid Becoming Prey

- Schooling
  - Safety in numbers
  - School may appear as single larger unit
  - Schooling maneuvers confuse predator

- Symbiosis – two or more organisms mutually benefit from association
  - Commensalism
  - Mutualism
  - Parasitism





(a)

- Commensalism – less dominant organism benefits without harming host

- Mutualism – both organisms benefit
  - Example: clown fish and anemone

- Parasitism – parasite benefits at expense of host

(b)

# Adaptations to Avoid Predation

- Speed
- Poisons
- Mimicry
- Transparency
- Camouflage
- Counter shading

# What Characteristics do Marine Mammals Possess?

- Marine mammals are descendants of land animals
  - Mammals already existed in the Mesozoic but with the extinction of 85% of all species (including all dinosaurs) at the end of the Cretaceous (65 million years ago) they were able to occupy the newly available niches and “boom”, developing all the major groups of today within 10 million years

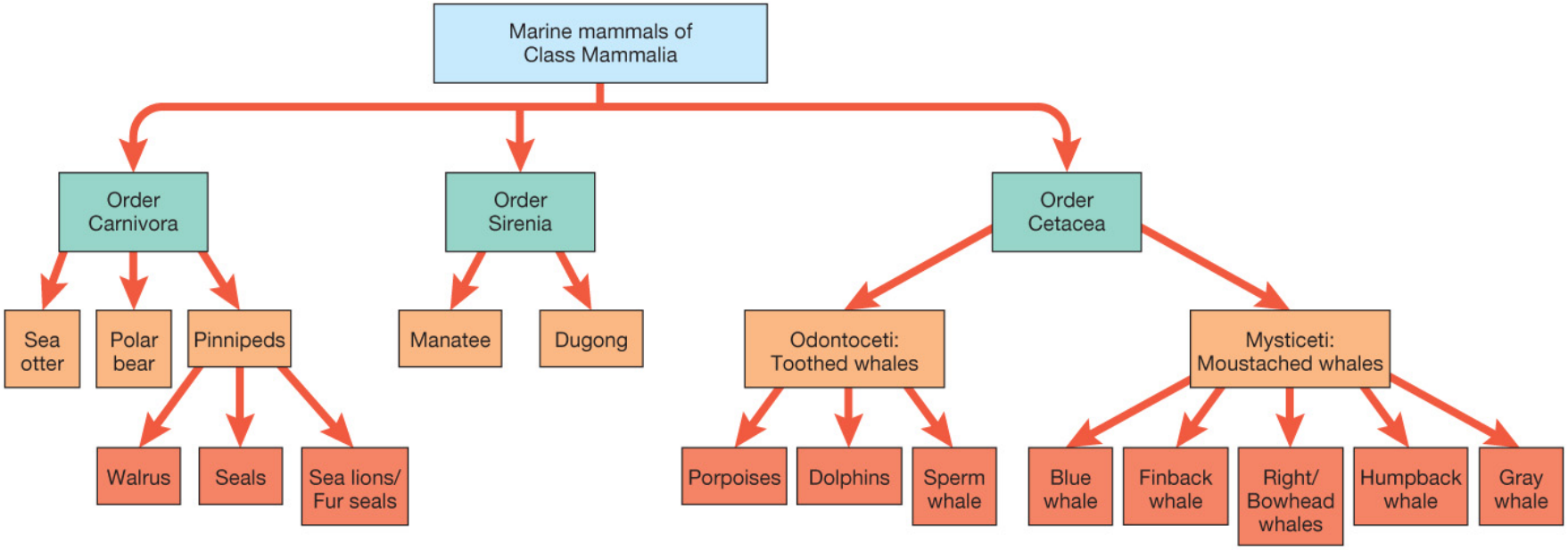
# What Characteristics do Marine Mammals Possess?

- Lines of evidence for a land origin for marine mammals include:
  - Fossils that show the transition from hippopotamus-like animals to whales
  - DNA analysis
  - Anatomical similarities between land and marine animals

# What Characteristics do Marine Mammals Possess?

- Warm-blooded
- Breathe air
- Hair/fur
- Bear live young
- Mammary glands for milk

# Major Marine Mammal Groups



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# Order Carnivora

- Prominent canine teeth
- Sea otters
- Polar bears
- Pinnipeds
  - Walruses
  - Seals
  - Sea lions
  - Fur seals

# Carnivora

(a)



(b)



(c)



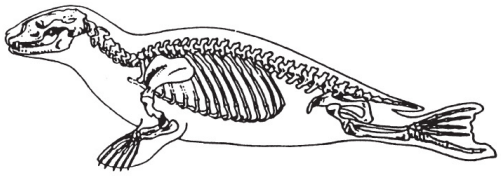
(d)



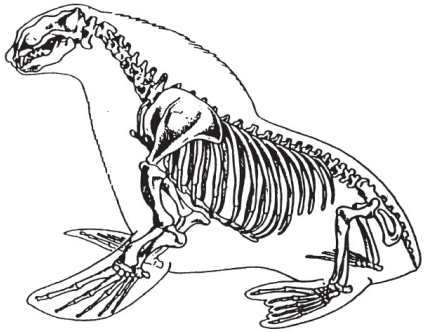
(e)

# Seals vs. Sea Lions and Fur Seals

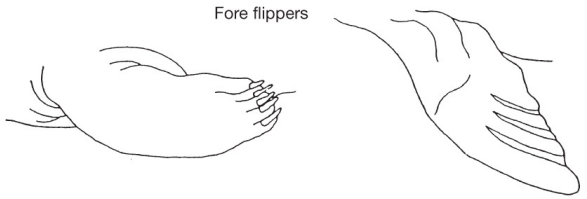
- Seals lack prominent ear flaps
- Seals have smaller front flippers
- Seals have fore flipper claws
- Different hip structures
- Different locomotion strategies



Skeleton of a typical seal, genus *Phoca*



Skeleton of the Steller sea lion



# Order Sirenia

- Herbivores
- Manatees
  - Coastal areas of tropical Atlantic Ocean
- Dugongs
  - Coastal areas of Indian and western Pacific Oceans

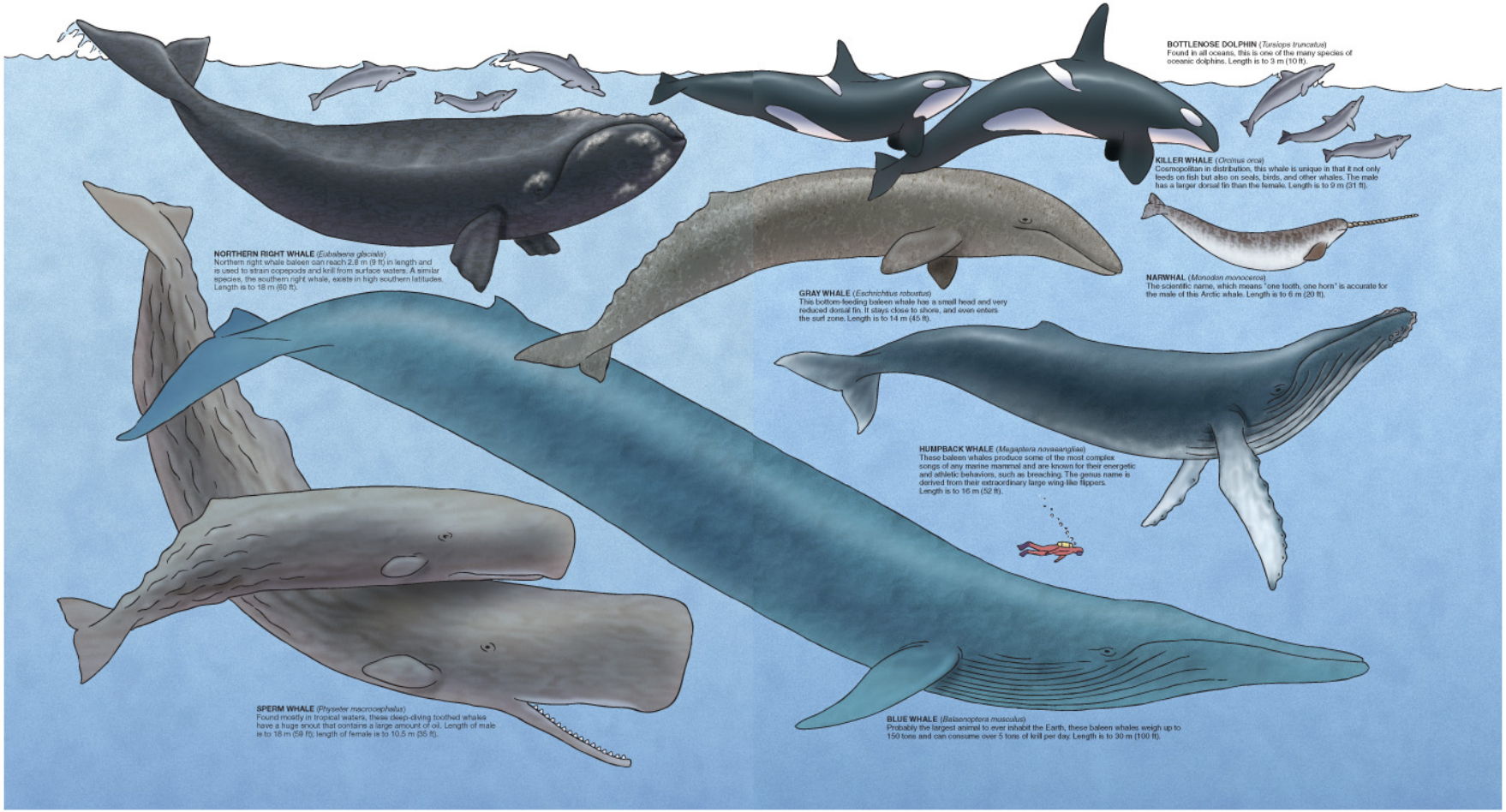
(a)

(b)

# Order Cetacea

- Whales, dolphins, porpoises
- Elongated skull
- Blowholes on top of skull
- Few hairs
- Fluke – horizontal tail fin for vertical propulsion

# Order Cetacea



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# Order Cetacea

- Adaptations to increase swimming speed
  - Streamlined bodies
  - Specialized skin structure
    - 80% water
    - Stiff inner layer
    - Narrow canals with spongy material

# Order Cetacea

- Adaptations for deep diving
- Use oxygen efficiently
  - Able to absorb 90% of oxygen inhaled
  - Able to store large quantities of oxygen
  - Able to reduce oxygen required for noncritical organs
- Muscles insensitive to buildup of carbon dioxide
- Collapsible lungs

# Order Cetacea

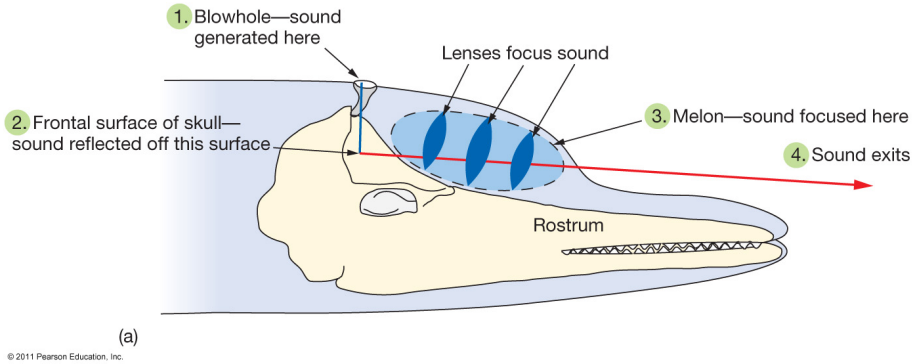
- Suborder Odontoceti (toothed)
  - Dolphins, porpoises, killer whale, sperm whale
  - Echolocation to determine distance and direction to objects
  - Determine shape, size of objects

# Dolphins vs. Porpoises

- Porpoises
  - Smaller, more stout body shape
  - Blunt snout
  - Triangular, smaller dorsal fin
  - Blunt or flat teeth
- Dolphins
  - Larger, more streamlined shape
  - Longer rostrum
  - Falcate dorsal fin (hooked)
  - Pointy teeth like killer whales (orca)

# Echolocation

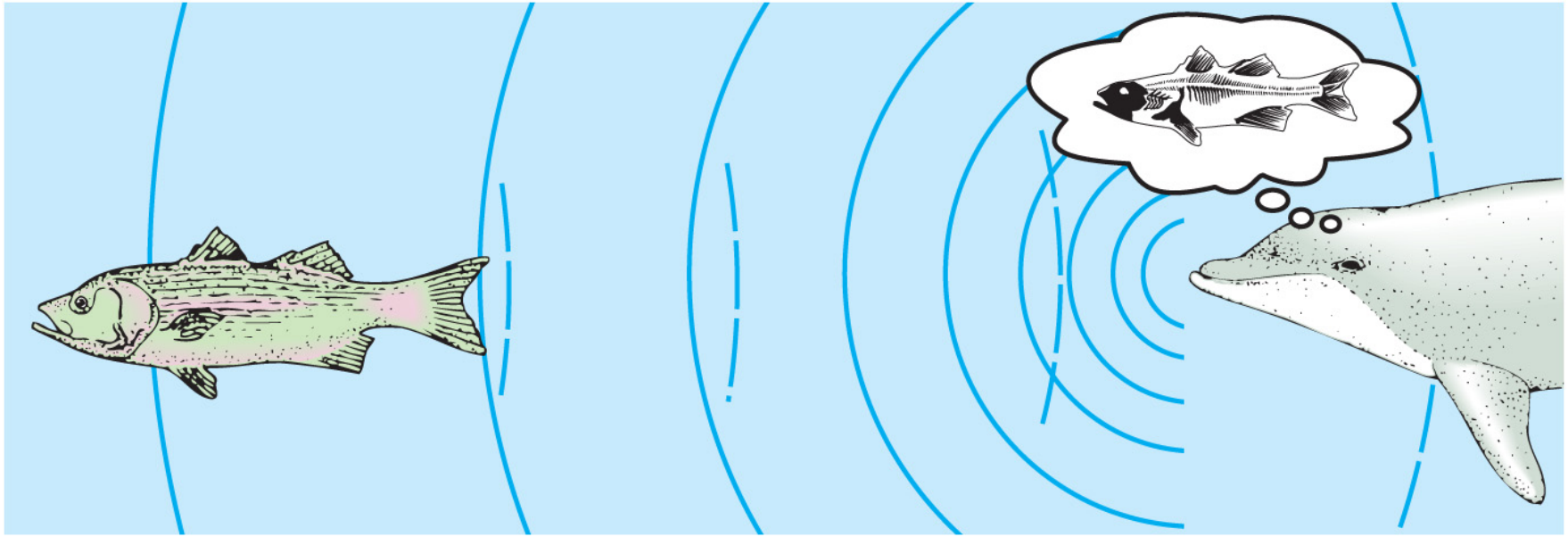
- Good vision of marine mammals is limited by ocean conditions.
- Mammals emit clicks of different pitches.
  - Low frequency – great distance
  - High frequency – closer range
- Dolphins can detect schools of fish at more than 100 meters (330 feet).



# Echolocation

- Toothed whales send sound through water.
- Sound is reflected, returned to the animal, and interpreted.
- An evolved inner ear structure may help toothed whales pick up sounds.
- Increased marine noise pollution may affect cetacean echolocation.

# Echolocation



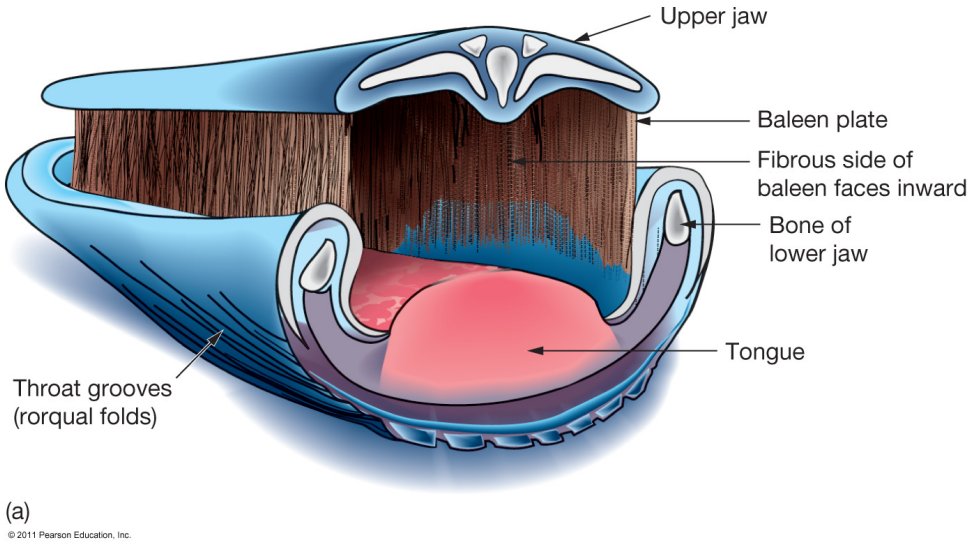
# Intelligence in Toothed Whales

- Large brains relative to body size
- Communicate with each other
- Brains convoluted
- Trainable

# Order Cetacea

- Suborder Mysticeti
- Baleen whales
- Blue whale, finback whale, humpback whale, gray whale, right whale
- Fibrous plates of baleen sieve prey items
- Vocalized sounds for various purposes

# Use of Baleen

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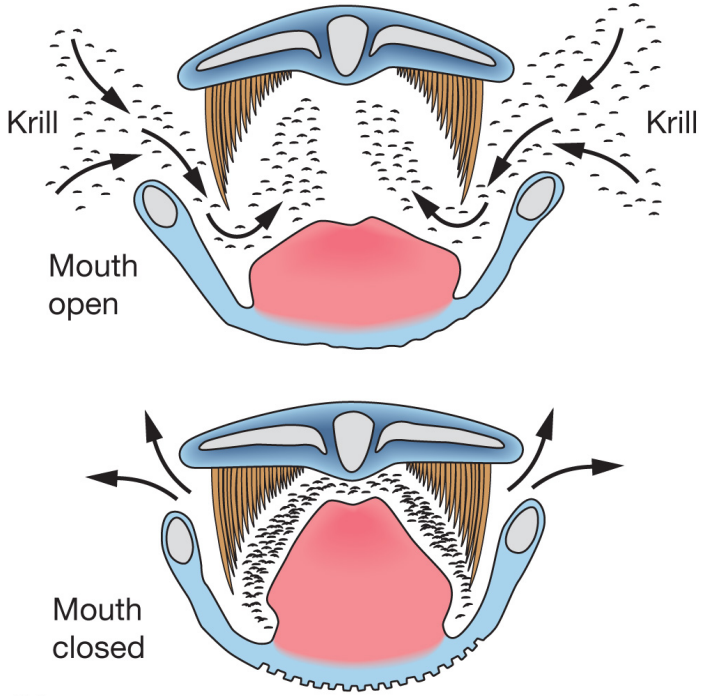


(b)

# Baleen Whale Families

- Gray whales
- Rorqual whales
  - Balaenopterids
  - Megapterids – humpback whales
- Right whales

# Gray Whale Migration

- 22,000 km (13,700 miles) annual migration from coastal Arctic Ocean to Baja California and Mexico
- Feeding grounds in Arctic (summer)
- Breeding and birthing grounds in tropical eastern Pacific (winter)

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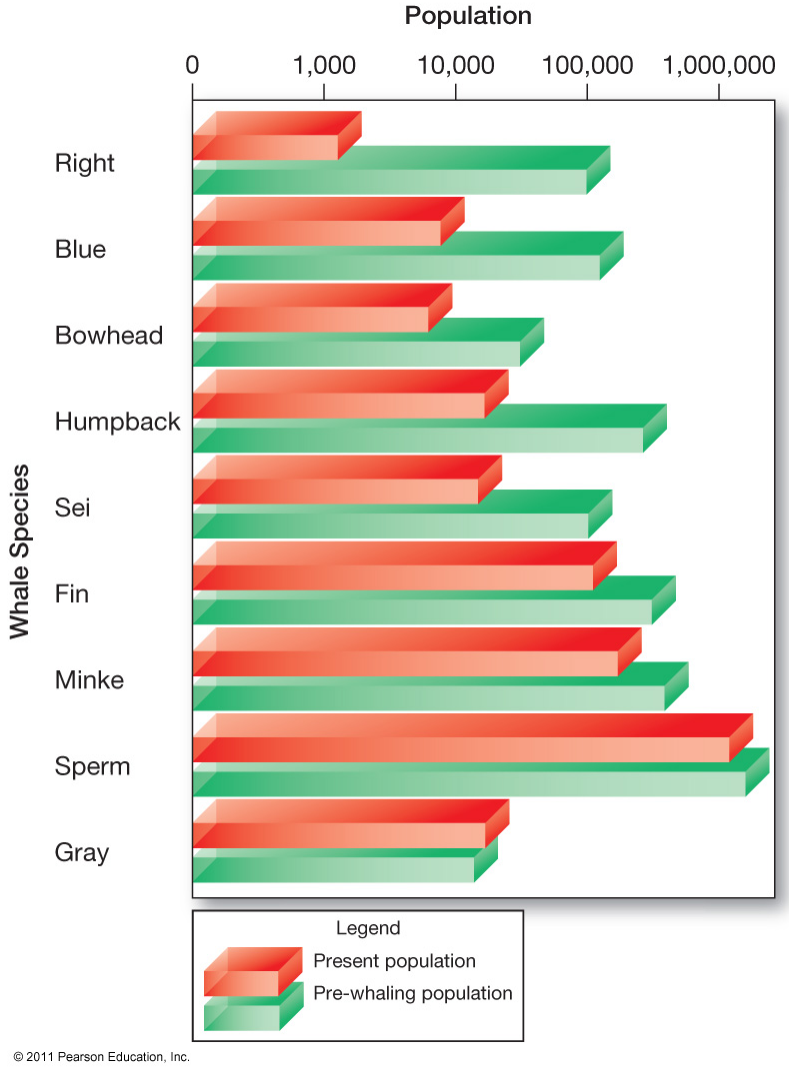
# Whales as Endangered Species

- Fewer whales now than before whaling
- International Whaling Treaty
- Hunting of gray whale banned in 1938
- Gray removed from endangered list in 1993 as population rebounded



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# Gray Whale Friendly Behavior

# Whaling

- International Whaling Commission (IWC) 1948
  – established to manage whale hunting
- In 1986, 72 IWC nations banned whaling
- Three ways to legally hunt whales:
  – Objection to IWC ban
  – Scientific whaling
  – Aboriginal subsistence whaling

# End of CHAPTER 14
# Animals of the Pelagic Environment