Ninth Edition

Biology of Marine Life

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Chapter 6 Marine Vertebrates

Phylum Chordata Subphylum Vertebrata



Vertebrate Features Vertebrates are chordates with an internal skeleton (endoskeleton) of cartilage or bone with a supportive backbone (vertebral column) made up of individual vertebrae



Marine Fishes

- Fishes include about 50% of all living vertebrates.

- Class Agnatha (jawless fish)
- Class Chondrichthyes (cartilaginous fish)
- Class Osteichthyes (bony fish)

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Why don't fish
drown???
How do fish deal
with the salt???
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Marine Fishes - Phylum Chordata Subphylum Vertebrata

Class Agnatha—The Jawless Fishes

- Include:
 - Hagfish
 - Lampreys
- 🖛 Don't have
 - Jaws
 - Paired fins
 - Scales
- Have
 - Slime (hagfish)
 - Anadromous lifestyle (lampreys)
 Salmon anadromous
 - Cartilaginous skeletons



http://www.youtube.com/v/Bb2EOP3ohnE

Hagfishes





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Lampreys

Hi everyone!!!







I would love to eat...I mean meet you for lunch!!!

http://www.youtube.com/v/jYBesqhG8bE

Marine Fishes - Phylum Chordata Subphylum Vertebrata

Class Chondrichthyes – the cartilaginous fish

- Include:
 - Sharks
 - Skates & Rays
 - Chimaeras
- 🖛 Have
 - Jaws
 - Paired fins
 - Cartilaginous skeletons
 - Heterocercal tail
 - Larger sizes
 - No swim bladders
 - Oviparity and ovoviviparity















http://www.youtube.com/watch? v=GMEqMma8Knw



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Marine Fishes - Phylum Chordata Subphylum Vertebrata Class Osteichthyes—The Bony Fish

- Include:
 - Ray-finned fish (thousands of species)
 - Lobe-finned fish (one species)
- 🖛 Have
 - Jaws
 - Paired fins
 - Bony skeletons smaller sizes
 - Homocercal tail
 - Swim bladders

http://www.youtube.com/ watch? v=NzzxOIFJtzg&feature=



coelacanth



Fig. 6.13 Some representative body types of nine common orders of marine fishes.



Order Perciformes, French Grunt

© Dwight Smith/ShutterStock, Inc.



Order Tetraodontiformes, Triggerfish © Konovalikov Andrey/ShutterStock, Inc.



Order Pleuronectiformes, Flounder © Heather L. Jones/ShutterStock, Inc.

Osteichthyes-The Bony **Fishes**



Order Anguilliformes, Eel © Russell swain/ShutterStock, Inc.



Order Scorpaeniformes, Scorpionfish Courtesy of Florida Keys National Marine Sanctuary /NOAA © Russell swain/ShutterStock, Inc.



Order Perciformes, Yellowtail Snapper

Order Atheriniformes, Flyingfish

Courtesy of Shannon Rankin,

NMFS. SWFSC/NOAA



Order Gasterosteiformes, Seahorse © Vova Pomortzeff/

ShutterStock, Inc.



Order Clupeiformes, Anchovy Courtesy of OAR/National Undersea Research Program (NURP)/NOAA



Order Perciformes, Grouper



Order Salmoniformes, Salmon Courtesy of the U.S. Fish and Wildlife Service



Order Perciformes, Damselfish © 2009 Jones and Bartlett Publishers, LLC (www.jbpub.com) © Joe Barbarite/ShutterStock, Inc.



Fins



Osteichthyes The Bony Fishes

Fig. 6.15 Names of fins and their positions on a derived teleost fish. A portion of the integument has been removed to show the arrangement of muscle myomeres.

Marine Fishes



Osteichthyes The Bony Fishes

Fig. 6.18 A flyingfish, *Exocoetus*, uses enlarged pectoral fins for gliding.

Why do fish come in so many different shapes???

Shape of body determined by lifestyle

Fusiform body shape: streamlined shape with a very high and narrow tail

- efficient movement for active swimmers



Laterally compressed or deep body

- allows
 navigation
 through
 - complex habitat, e.g., grass or corals



Depressed or flattened bodies

bottom-dwelling fishes



Globular bodies, enlarged pectoral fins — appropriate for sedentary lifestyle



The Biology of Fishes: Body Shape Long, snake-like bodies, absent or reduced pelvic and pectoral fins

useful for burrowing, living in tight spaces



Fish Coloration and Patterning



countershading

Disruptive coloration



Fish Coloration and Patterning



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Marine Fishes Bony Fishes

- The sex is more variable in bony fishes than in other groups (some genes are not on sex chromosomes!)
- It's about the hormones!!!
- Some are hermaphroditic.
 - simultaneous or sequential.
 - Sequential hermaphrodites are either protogynous (f to m) or protandrous (m to f).









Marine Tetrapods Includes reptiles, birds, and mammals.

🖛 4 limbs

- Air-breathers (lungs) with terrestrial ancestor



Phylum Chordata Subphylum Vertebrata Class Reptilia





Class Reptilia Crocodiles, turtles, lizarsds, snakes 1st group to possess amniotic egg!



Marine iguana, Amblyrhynchus, of the Galapagos Islands





© Aqua Image/age fotostock



Green sea turtle, *Chelonia* J Lawrence Cruciana/ShutterStock, Inc.

Class Reptilia - Crocodilians

Crocodilians, close relatives of birds, are the only reptiles with a fourchambered heart (like birds and mammals)



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Fig. 6.23 (a) The saltwater crocodile, *Crocodylus*, on an Indo-Pacific beach.

(b) Beach warning sign on Australia's northeast coast.

Class Reptilia - Turtles 7 species of sea turtles Fig. 6.24 The Internet Fig. 6.24 The Internet Provided Action of the Start S

Fig. 6.24 The leatherback (no shell) sea turtle, *Dermochelys coriacea*.





Hawksbill



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Loggerhead



Flatback

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Olive Ridley

Turtle Reproduction



Fig. 6.25 The green sea turtle, *Chelonia mydas*, laying eggs in a sandy beach nest.

Incubation temperature can determine sex!

females return to beaches where they were born to nest

© 2010 Cengage http://www.youtube.com/watch?v =1Bq-IFUPBSA&feature=related

© 2009 Jones and Bartlett Publishers, LLC (www.jbpub.com) Fig. 11-7, p. 303

Dealing with salt!!!

Marine Reptiles and Birds

- Marine reptiles, and sea birds, eliminate excess salts via their:
 - kidneys
 - specialized salt glands contained in their mouths, nostrils, or orbits



Fig. 6.26 A lesser albatross nasal openings for salt



Phylum Chordata Subphylum Vertebrata Class Aves

"Marine" birds range from those that are:

- nearly full-time residents of the sea, such as penguins
- species that simply visit the shoreline to feed, such as some ducks, geese, and coots.







Class Aves – Birds

It's cold for birds & mammals!

- 1. Feathers/blubber/hair/fur
- 2. Countercurrent vascular system in feet/wings
- 3. streamlined bodies

Warm

4. primary propulsion muscles (which generate heat) located in their torso

Cool



through the adductor muscle of bivalves

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(a)

PLOVERS http://www.youtube.com/watch? v=080bmea2Fts&feature=related _{Fig. 11-12, p. 309}









SANDPIPERS

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© 2009 Jones and Bartlett Publishers, LLC (www.jbpub.com) Fig. 11-14, p. 310

Heron









Fig. 11-16, p. 311







SKUAS – the hawks/falcons of the ocean © 2009 Jones and Bartlett Publishers, LLC (www.jbpub.com) Fig. 11-18, p. 312





© 2009 Jones and Bartlett Publishers, LLC (www.jbpub.com) Fig. 11-19, p. 312



http://www.youtube.com/watch? $v = sOq8AIGVTbk \&feature related {\tt ub.com}$





red-footed booby



(a)

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Fig. 11-24, p. 315

Masked booby



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id Bartlett Publishers, LLC (www.jbpub.com) Fig. 11-24, p. 315

CORMORANT.



http://www.youtube.com/watch?



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its red throat to attract mates

© 2009 Jones and Bartlett Publishers, LLC (www.jbpub.com) Fig. 11-26, p. 316





Fig. 11-27, p. 317







http://www.youtube.com/watch? v=B8yyQhQDjVU&feature=relate d

EMPEROR PENGUIN. This male emperor penguin is incubating an egg.



Phylum Chordata Subphylum Vertebrata Class Mammalia Marine Mammals are all placental mammals

- Three orders of mammals can be found in the sea, including:
 - Order Carnivora (sea otters and pinnipeds & polar bears)
 - Order Sirenia (manatees and dugong)
 - Order Cetacea (whales, dolphins, and porpoises)



 Hair or fur (mostly)
Endothermic
Viviparity
mammary





Marine Mammals Order Carnivora (sea otters and pinnipeds) Consume 25% of body weight each day! Thick fur, no blubber!!!



=epUk3T2Kfno

© 2009 Jones and Bartlett Publishers, LLC (www.jbpub.com) Fig. 12-1, p. 327

http://www.youtu **Class Mammalia** http://www.youtube. be.com/watch? com/watch? **Order Carnivora** v=DxVMnJXWvd v=Ob oD1IsYbE&fe M&feature=relat ature=relapinnipeds "feather-footed" include seals, elephant seals, sea lions, and walruses



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Fig. 6.34 Two types of pinnipeds: a harbor seal, *Phoca* (left) and Steller sea lions, Eumetopias (right).

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Marine Mammals

Class Mammalia

Order Carnivora (sea otters and pinnipeds)



Fig. 6.35 California sea lion, Zalophus, swimming with typical "flying" motion of flippers.





STELLER'S SEA LIONS — fur seal © 2009 Jones and Bartlett Publishers, LLC (www.jbpub.com) Fig. 12-A, p. 332






http://www.youtube.com/watch? v=JUopYgVh-3o&feature=fvw

http://www.youtube.com/watch? v=VV61sISrIEU

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Marine Mammals

Order Sirenia (manatees and dugong)

• Herbivores, docile



Fig. 6.36 Manatee cow and calf (*Trichechus*).



Steller's Sea Cow 30 yrs

http://www.youtube.com/watch? v=F9I1wenWFQg



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(a)



Manatee

http://www.youtube.com/watch? v=fGJAofqTF7A&feature=related



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Class Mammalia

- OrderCetacea
 - whales
 - dolphins
 - porpoises



Fig. 6.37 A few species of cetaceans, showing the immense range of body sizes at maturity. Baleen whales are on the left, toothed whales on the right.





Marine Mammals

- 🖛 Cetacea
 - whales
 - dolphins
 - porpoises

Fig. 6.38 A 70-day embryo of a gray whale. Note the definite rear limb buds (arrow).



Reproduced from Rice and Wolman, Life History and Ecology of the Gray Whale (Eschrichtius robustus). Spec. Publ. No. 3, (1971). American Society of Mammalogists, Allen Press, Inc.; Courtesy Dale W. Rice





Marine Mammals Mammals Cetacea • whales • dolphins • porpoises



Fig. 6.39 Left-side baleen plates of a rehabilitating year-old gray whale, "JJ," with Jim Sumich (right). © 2009 Jones and Bartlett Publishers, LLC





narwhals

(b)



(a) © 2010 Cengage Leamin

Marine Mammals

2010 Cent

- 🖛 Cetacea
 - whales
 - dolphins
 - porpoises



Fig. 6.40 Volunteers struggle to save a pod of stranded whales.





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KILLER WHALE

http://www.youtube.com/watch? v=W8GaDuCvYbE&feature=relate

Breath-Hold Diving in Marine Mammals





How can they do this???



Diving and Breath-Holding Capabilities of a Few Mammals

JIC 6.2	Animal	Max. depth (m)	Max. duration of breath-hold (min)
	Human (Homo)	67	6
	Dolphin (Tursiops)	535	12
	Sperm whale (Physeter)	3000	138
	Fin whale (Balaenoptera)	500	30
	Sea lion (Zalophus)	482	15
	Weddell seal (Leptonychotes)	626	82
	Elephant seal (Mirounga)		
	Male	1530	89
	Female	1273	120
	Walrus (Odobenus)	100	13
	Manatee (Trichechus)	600	6
	Sea otter (Enhydra)	23	2.3

Data from Scheer and Kovacs (1997) and Berta and Sumich (1999).

© 21

Breath-Hold Diving in Marine Mammals



Higher O_2 uptake from: 1. Lower breathing rates/change in pattern (apneustic breathing) Elastic tissues in lungs 2. Blood volume higher. More hemoglobin too. Blood storage different (not in lungs - which collapse in marine mammal divers!) 3. Vasoconstriction 4. Lactate accumulation in muscles - reduced aerobic metabolism (less O2 needed) 5. Bradycardia

Vertebrate Sensory Capabilities



Vertebrate Sensory Capabilities Chemoreception



Fish = great smellers!

Marine tetrapods all close their nostrils, so not so much!.

Vertebrate Sensory Capabilities Electroreception and Magnetoreception

- The ability to detect weak electric and electromagnetic fields has been demonstrated in:
 - Bacteria, cartilaginous and bony fishes, some birds, & possibly some whales

Ampullae of Lorenzini

- organs scattered over the top and sides of shark (and relatives) head
- sense electrical currents in water: used for locating possible prey!



Vertebrate Sensory Capabilities Vision

- Low quality and quantity of light available under water.
- Have a "camera" eye. Focus by moving the lens within the eye (rather than changing its shape, like ours do).
- They detect light with altered ratios of photoreceptor cells and unique visual pigments.

Fig. 6.47 Cross-section of a fish eye. Note the solid, round lens that is focused by being moved toward or away from the retina by the retractor muscle.





Vertebrate Sensory Capabilities Sound Reception—Fishes

- Sound travels about five times faster in water
- Neuromasts within lateral lines and labyrinth organs detect sounds.





http://www.youtube.com/watch? v=4d5GkW8ix54&feature=related

Helps fish school. Why would fish school?

Vertebrate Sensory Capabilities Sound Reception—Tetrapods

- Similar to land tetrapods, but sound is different in water (5 X faster)!!!
- Cetaceans have evolved alternative routes for sound - mostly goes through their lower jaw, not their "ears"!



Fig. 6.50 Midsection of a dolphin head, showing the bones of the head, the air passages, and the structures associated with sound production and reception.

