Bony Fishes
Comparing and Contrasting
CLASS - OSTEICHTHYES

• Class Osteichthyes includes all bony fishes.
• Osteichthyes are cold-blooded vertebrates that breathe through gills and use fins for swimming.
• Bony fishes share several distinguishing features: a skeleton of bone, scales, paired fins, one pair of gill openings, jaws, and paired nostrils.
Did you know?

• Osteichthyes includes the largest number of living species of all scientific classes of vertebrates, more than 28,000 species.

• Osteichthyes account for about 96% of all fish species. Fishes not included in the Osteichthyes are the Chondrichthyes (sharks and their relatives), the Myxini (hagfishes), and the Cephalaspidomorphi (lampreys).
The Devonian period, about 360 to 400 million years ago, is known as the "Age of Fishes", because of the abundance and diversity of fishes that appeared during this period.

In the Devonian, fishes began to develop jaws and paired fins.

Many species of fish that lived during the Devonian are now extinct.
DISTRIBUTION

• Bony fishes inhabit almost every body of water. They are found in tropical, temperate, and polar seas as well as virtually all fresh water environments.

• About 58% of all species of bony fishes (more than 13,000 species) live in marine environments. Although only 0.01% of the earth's water is fresh water, freshwater fishes make up about 42% of fish species (more than 9,000 species).
• Different species of fish are adapted for different habitats: rocky shores, coral reefs, kelp forests, rivers and streams, lakes and ponds, under sea ice, the deep sea, and other environments of fresh, salt, and brackish water.

• Some fish are pelagic: they live in the open ocean. For example, tunas.

• the flatfishes (order Pleuronectiformes) are adapted for living along the bottom

• At the opposite extreme, some species of bony fishes can survive freezing temperatures of the Arctic and Antarctic. Certain glycoprotein molecules present in the blood of these specially-adapted fishes lower the freezing point of the blood. The arctic cod (Boreogadus saida) can survive temperatures as low as -2°C (28°F).
Migration

• Most bony fishes have small home ranges.
• Some species of bony fishes migrate great distances. Food and habitat availability, reproduction, environmental cycles and temperature change may be causes of migration for some species.
• Some bony fish species are *diadromous*: they migrate between fresh and marine environments.
• Some fish are *catadromous*: they live in freshwater environments but migrate downriver to the ocean to spawn.
• *Anadromous* fishes live most of their lives in the ocean, but migrate into freshwater environments to spawn.
Size

- Thousands of species of bony fishes are less than a few centimeters long as adults. Among the smallest is the endangered dwarf pygmy goby (*Pandaka pygmaea*). Adult males reach just 15 mm (0.6 in.), and adult females reach only about 9 mm (0.4 in.).
- The longest bony fish is the oarfish (*Regalecus glesne*), which can reach 11 m (36 ft.).
- Among the heaviest of the bony fishes is the common ocean sunfish (*Mola mola*), which lives throughout warm and temperate seas worldwide. A large sunfish can reach 3.3 m (10.8 ft.) and 2,300 kg (5,071 lb.).
Body Shape: Laterally Compressed

- Flattened side by side
- Leisurly swimming around coral reefs, kelp beds, rocky reefs
- Still capable of short bursts of speed
Body Shape: streamlined

• Body shape is directly related to lifestyle
• Here are some examples:
  • Sharks, tunas, marlins are streamlined → fast
Body Shape: Laterally Flattened also known as depressed

- Flat and adapted to live on bottom
- Lie on one side with both eyes on top
- Begin life with eye on either side
  - Eyes migrate together as they grow older
Body Shape: Elongated

- Live in narrow spaces in rocks or coral reefs
Combo of body shapes!

- The body shape of some species differs from or combines features of these typical fish body forms. Examples include boxfishes (family Ostraciidae), ocean sunfishes (family Molidae), seahorses (*Hippocampus* spp.), the weedy seadragon (*Phyllopteryx taeniolatus*), and the leafy seadragon (*Phycodurus eques*).
Color and Camouflage

• Most species have pigmentation
• Most species are **countershaded**: dorsal (top) surface is darker than the ventral (underneath) surface
• Some are colored for camouflage
• others become brighter in color during breeding season
• Some fish **bioluminate (emit light)**
  This might help attract mates, deter or confuse predators, attract prey, or act as "headlights" to help a fish see in the dark.

Pipefish (can you find them in the eel grass?)
Fins

- Except in the lungfishes and the coelacanth, fins lack bones

What are the functions of the various fins?

- Dorsal fin: stabilization
- Pectoral fin: balance, turning
- Anal fin: stability
- Caudal fin: motion, propulsion
- Pelvic fin: balance
Head

- Eye size and position vary depending on the habitat and behavior of the species.
- In most species, the gills are protected by a flexible plate called an **operculum**. Most bony fishes have a single pair of gill openings. Some bony fishes such as eels (family Anguillidae) have a pair of gill holes or pores that aren't covered by an operculum.
- The nostrils of most bony fishes have no connection with the mouth or gills.
- **Mouth shape and size are good indications of bony fish's feeding habits.**
Feeding: Shape of Mouth

- **Protrusible** jaws allow flexibility in feeding habits
- **Mostly carnivores**
- Very diverse in the ways they feed
- Capture prey
  - sediments; water column; rocks; off other organisms; chase prey; sit and wait

A 20 lb Tiger Fish from the Congo, Africa
What does this fish eat?

- Long billed butterfly fish
  - Long snout, small mouth feeds on very small prey
What does this fish eat?

- Barracuda
  - Uses teeth to tear off chunks of prey
What does this fish eat?

- **parrotfish**
- Grind up coral and extract algae from its polyps.
Scales

- **Most bony fishes have cycloid or ctenoid scales.**
  - Both cycloid and ctenoid scales consist of an outer layer of calcium and an inner layer of connective tissue.
  - Cycloid scales overlap from head to tail, an arrangement that helps reduce drag as a fish swims.
- **Cycloid scales are circular and smooth. They are most common on fishes with soft fin rays.**
- **Ctenoid scales have a characteristic toothed edge. They are most common on fishes with spiny fin rays.**
- As a fish grows, cycloid and ctenoid scales add concentric layers.
- Some bony fishes may have scales only on portions of their body, and some species have no scales.
Body spines

• Some fish have body spines that are modified scales
• Protective spines are common in slow-swimming fishes and others that need to protect themselves without moving.
Why do fish feel slimy?

- **MUCUS**!

A fish secretes a layer of mucus that covers its entire body. Mucus helps protect a fish from infection.
Skeletal system

• The skeleton of a bony fish gives structure, provides protection, assists in leverage
Muscular system

- Aids in locomotion!
- Swim side to side (S-shape)
- Contractions produced by myomeres
  - Bands of muscle running along side of body
  - Large percent of body weight—70% in salmon!
Fish Muscles

• 3 types
  – Red, pink, and white
• Most fish have a combo of 2 or 3 types
• What makes the red muscles red?
  • A lot of capillaries → a lot of blood flow
• Different types of muscles have different jobs.
Red vs. Pink vs. White Muscle

- Red muscle
  - Slow muscle
  - A lot of oxygen (hemoglobin)
  - steady, constant-effort swimming
  - Open ocean swimmers (tuna, mako)

- White muscle
  - Fast muscle
  - Reduced blood $\rightarrow$ less oxygen
  - anaerobic, works for short periods of time
  - Quick bursts of movement

- Pink Muscle
  - Intermediate; continued high speed swimming for 20-30 minutes
Nervous system

• The nervous system of fishes is poorly developed compared to that of other vertebrates.

• A bony fish's brain is divided into three sections: the forebrain (smell), the midbrain (vision), and the hindbrain (movement/balance)

• The spinal cord and a matrix of nerves serve the rest of the body.
Circulatory System

- 2 chambered heart: atrium and a ventricle
- Deoxygenated blood enters 1\textsuperscript{st} chamber of heart from body
- 2\textsuperscript{nd} chamber pumps this blood into gills
- Gas exchange takes place
- Oxygenated blood carried to rest of body
Digestive system

- The esophagus in bony fishes is short and expandable so that large objects can be swallowed.
Respiratory System

- Water enters the gill chamber through a fish's mouth and exits through gill openings under the operculum. Blood flowing through the gill filaments absorbs oxygen from the water.
Osmoregulation

Marine fishes live in water that is saltier than their body fluids -> water tends to diffuse out of their bodies

To prevent dehydration:
Cartilaginous fish concentrate urea (waste products), absorb seawater through gills and skin, excrete salts through urine/feces. Their blood has salt concentration that is = or greater than seawater

Bony fishes don’t concentrate urea—it’s toxic to them. Constantly losing water through osmosis. Kidneys conserve water, drink sea water, excreting excess salts
Smell

- Olfactory cells
- INTERNAL GPS
- Studies suggest that smell guides at least some species of salmons (family Salmonidae) to their home streams during the breeding season.
Activity

- Some species of fish, such as tunas, swim continually.
- Many species spend most of their time lying on the ocean bottom.
- Bottom-dwellers include stonefishes (Synanceja spp.), flatfishes (order Pleuronectiformes), and blennies (family Blennidae).
- Certain species have peak activity times during a day.
The Tuna: A Swimming Machine

• Never stop swimming
• Cover vast distances
  – 7,000 miles!
  – Northern bluefin cross Atlantic in 119 days (40 miles/day)
• Endurance swimmers
• Capable of high speed bursts
• It’s all about the adaptations . . .
Tuna: Streamlined Perfection

- Lack scales
  - Smooth and slippery
- Eyes
  - Lie flush with body; don’t protrude
- Fins
  - Stiff, smooth, narrow
  - Tuck into body groove when not in use
- Keels, finlets and corselet
  - Direct water flow over body to reduce resistance

- Body temperature: can maintain a core temp of 77°F in water temp of 45°F.
Schooling

• Schooling is an adaptation for avoiding predators
• Schooling poses a hydrodynamic advantage and increases reproductive success
Food intake

• The amount of food a bony fish eats is directly related to its size, its metabolic rate, and the temperature of its environment.

• Smaller fishes generally have a higher metabolic rate than large fishes of the same species. Thus, small fishes generally eat proportionately more.

• Warm-water fishes generally require more food than similar-size cold-water fishes. A fish's body temperature - and its metabolic rate - is determined by the temperature of its environment.
Cartilaginous vs. Bony Fish

% species

• Bony fish: 23,000 species
  – That’s 96% of all fishes!
• 75-100 new species each year
**Cartilaginous vs. Bony Fish**

- **Bony fish** have a **swim bladder**
  - Gas filled sac
  - Adjusts **buoyancy**
  - Compensates for the heavy skeleton

Cartilaginous fish **DO NOT** have a swim bladder, they only have their **liver** to help with buoyancy.
Cartilaginous vs. Bony Fish scales

- Have cycloid or ctenoid scales
  - Thin, flexible and overlapping
  - Covered by thin layer of skin and mucus
- Sharks placoid
Cartilaginous vs. Bony Fish

- **Operculum** – Gill cover
- **Cartilaginous fish**: gill slits
Cartilaginous vs. Bony Fish

Bony fish have a terminal mouth
  – Located at anterior end

Cartilaginous fish have a mouth ventrally located
Cartilaginous vs. Bony Fish

- Teeth attached to jawbone, teeth are irreplaceable

- Cartilaginous teeth not fused to jaw, teeth are replaceable
Cartilaginous vs. Bony Fish

- Shark species have eyelids
- Bony fish lack eyelids
Cartilaginous vs. Bony Fish

- Shark fins are **stiff and lack fine bony spines and muscle**. Flexible fins mean **bony fish can swim forwards and backwards** but sharks are stuck only going forward.
- Shark caudal fin: **heterocercal** = two lobes are unequal in size and the vertebral column extends up into the top lobe.
- Bony fish are **homocercal**, having symmetrical lobes that extend past the end of the vertebral column.
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Sharks vs. bony fish life history

- Sharks
  - Slow growth, low reproduction numbers

- Bony fish
  - Rapid growth, lots of offspring