NO PREP

# Fish in the Sea

## Anatomy, Physiology, and Adaptations

**Includes:** Student reading, case study, differentiated questions, teacher key

Name: Period: Date:

### Fish in the Sea: Anatomy, Physiology, and Adaptations

**Introduction to Fish as Marine Vertebrates**

Fish are the most diverse group of marine vertebrates, with tens of thousands of species inhabiting the world's oceans. They are crucial to marine ecosystems because they occupy nearly every level of the food chain, from small plankton-eating species to large predators like sharks and tuna. Fish are also important to humans as a major source of food, culture, and economic activity. Scientists often divide fish into two broad groups: cartilaginous fish (sharks, rays, and skates) and bony fish (the vast majority of species, including cod, salmon, and clownfish). Each group has unique anatomical features, physiological functions, and evolutionary adaptations that help them survive in marine environments. Fish exhibit an incredible variety of

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## Anatomy and Physiology of Cartilaginous vs. Bony Fish

Cartilaginous fish, known scientifically as Chondrichthyes, have skeletons made of cartilage, which is lighter and more flexible than bone. This adaptation makes them agile predators, capable of quick bursts of speed. Sharks, for example, have streamlined bodies, multiple rows of replaceable teeth, and large, powerful fins designed for efficient swimming. Rays and skates, on the other hand, have flattened bodies with wing-like pectoral fins that allow them to "fly" through the water. Bony fish, belonging to the class Osteichthyes, make up about 95% of all fish species. Their skeletons are composed of bone, which provides more structural support than cartilage. They also have swim bladders, internal gas-filled organs that allow them to

regulate buoyancy without constant swimming. This gives them an advantage over cartilaginous fish, which must keep moving to avoid sinking. Additionally, bony fish usually have opercula—bony plates that cover and protect the gills—making respiration more efficient.

**Adaptations for Marine Survival**

Both cartilaginous and bony fish display adaptations that allow them to thrive in their environments. Cartilaginous fish often rely on oil-rich livers for buoyancy and possess highly developed senses, making them effective hunters. Bony fish, with their wide variety of body shapes and fin arrangements, are adapted to diverse ecological niches. Some, like tuna, are built for fast, long-distance swimming, while others, like anglerfish, are adapted for ambush in the deep sea. Another important adaptation is the development of scales. Cartilaginous fish have tiny, tooth-like dermal denticles that reduce drag and turbulence as they swim. Bony fish, on the other hand, typically have overlapping scales that protect the body while still allowing flexibility. Respiration is also key to survival. Fish extract oxygen from water using gills, which contain thin filaments and capillaries that maximize surface area. The efficiency of this system allows fish to live in oxygen-poor environments that would be challenging for terrestrial animals.

**Fish Diversity and Ecosystem Roles**

Fish occupy every level of the marine food web. Small forage fish like sardines and anchovies feed on plankton and in turn support larger predators, including marine mammals and seabirds. Predatory fish such as sharks, groupers, and barracudas help regulate populations of smaller fish, keeping ecosystems balanced. Coral reef fish, with their vibrant colors and specialized feeding behaviors, demonstrate how fish have adapted to specific habitats. Fish also play roles beyond natural ecosystems. They are critical to human societies worldwide, providing protein, supporting jobs, and shaping cultural traditions. However, overfishing, habitat destruction, and climate change threaten many fish species, reminding us that their survival is closely linked to human activity.

**Key Information**

| Feature | Cartilaginous Fish (Sharks, Rays) | Bony Fish (Tuna, Salmon) |
|---|---|---|
| Skeleton | Cartilage | Bone |
| Buoyancy control | Must keep swimming | Swim bladder |
| Gill covering | Open gill slits | Operculum |
| Reproduction | Internal fertilization common | External fertilization common |
| Teeth | Multiple rows, replaceable | Fixed in jaw |

**Case Study: The Great White Shark vs. the Bluefin Tuna**

**Few marine animals capture human imagination as much as the great white shark and the bluefin tuna. Both are powerful, fast-swimming predators, but they represent very different evolutionary paths. The great white shark, a cartilaginous fish, can reach lengths of over 20 feet and is an apex predator, feeding on seals, fish, and even whales. Its skeleton made of cartilage allows it to move with surprising agility despite its size. The shark must constantly swim to keep water moving across its gills for respiration. Its liver, filled with oil, helps with buoyancy, but unlike bony fish, it does not have a swim bladder. In contrast, the Atlantic bluefin tuna, a bony fish, is known for its incredible speed and endurance. Unlike most fish, the bluefin is warm-blooded, allowing it to regulate its body temperature and survive in colder waters. The tuna's streamlined body and powerful muscles make it one of the fastest fish in the ocean, capable of bursts up to 40 miles per hour. Its swim bladder allows it to hover effortlessly in the water column. Unfortunately, while great white sharks are vulnerable due to low reproductive rates, bluefin tuna face serious threats from overfishing, as their meat is highly prized in global seafood markets.**

1. What are two major differences between how great white sharks and bluefin tuna achieve buoyancy?

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2. Why might the bluefin tuna's ability to regulate its body temperature give it an advantage in the ocean?

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**Multiple Choice**

1. Which of the following is a feature unique to bony fish?
    a) Multiple rows of teeth
    b) Open gill slits
    c) Cartilaginous skeleton
    d) Swim bladder

2. What adaptation allows sharks to maintain buoyancy?
    a) Operculum
    b) Overlapping scales
    c) Oil-rich liver
    d) Swim bladder

3. Which feature helps reduce drag in cartilaginous fish?
    a) Dermal denticles
    b) Teeth fixed firmly in the jaw
    c) Operculum
    d) Swim bladder

**Matching**

Write the letter of the correct definition on the line next to each term.

| Term | Definition |
|---|---|
| 1. ___ Skeleton made of cartilage | A) Swim bladder |
| 2. ___ Has operculum covering gills | B) Fixed teeth |
| 3. ___ Lets bony fish hover without constant swimming | C) Cartilaginous fish |
| 4. ___ How teeth are set in bony fish jaws | D) External fertilization |
| 5. ___ Common way bony fish reproduce | E) Bony fish |

**Fill-in-the-Blank**

1. The class _____ includes sharks, rays, and skates.

2. Bony fish regulate buoyancy using a _____.

3. Sharks must swim constantly to force water across their _____.

**Short Answer**

Answer each question in 2-4 complete sentences.

1. Explain why the swim bladder is considered an important evolutionary adaptation in fish.

_____

_____

_____

2. Describe one advantage and one disadvantage of a cartilaginous skeleton compared to a bony skeleton.

3. Based on the case study, why are great white sharks and bluefin tuna both vulnerable species, but for different reasons?