Lab 1: The Diversity of Fishes

The purpose of this lab is to familiarize you with the major groups of living fishes and their diagnostic features. Most of these groups are Orders, though we have also included specific higher groups that you need to know.

You are responsible for recognizing the major groups of fishes presented today. As well as being able to identify these groups by sight, you are expected to know specific diagnostic characteristics that distinguish these groups (i.e. the subset of characters we emphasize).

Subphylum: Cephalochordata

Order: Amphioxiformes

This group, commonly referred to as *amphioxus* or the *lancelets* is often ignored by invertebrate and fish texts. Though they have *no vertebrae, jaws, eyes, brain or cranium*, they are evolutionarily and anatomically more similar to fish than invertebrates. They possess a notochord, pharyngeal basket (used to filter feed), and atripore. They inhabit temperate and marine soft bottom substrates.

Subphylum: Vertebrata, Superclass Agnatha

Agnatha means 'jawless'. These fishes also have an unconstricted notochord, no true gill arches, no paired fins and a single median nostril.

Order: Myxiniformes

Hagfishes: Fleshy barbels, terminal nostril, degenerate eyes, direct development from large eggs. Temperate, marine. Mostly scavengers. ~30 spp.

Example: Hagfish
Order: **Petromyzontiformes**  
Lampreys: Median nostril not terminal, eyes generally functional. Freshwater or anadromous, parasitic or non-feeding as an adult. Ammocete larvae are filter-feeding detritivores. ~30 spp.  
*Examples: Sea lamprey, Mountain brook lamprey*

Subphylum **Vertebrata**, Class **Chondrichthyes**  
This class of fishes is characterized by: cartilaginous vertebrae, which constrict the notochord; true gill arches, attached (but not fused) to the brain case; paired fins and nostrils, placoid scales, intromittent organs (claspers or myxopterygium) for internal fertilization.

Subclass: **Holocephali**  
Order: **Chimaeriformes**  
Ratfishes: Single gill cleft covered by operculum, no spiracle, hyostylic jaw suspension, skin naked except along lateral line. ~25 spp.  
*Examples: chimaeras, ratfish*

Subclass: **Elasmobranchii**  
5 orders of sharks and rays, differing greatly in dentition, external form, and cranial characters; range in size from small to very large

Order: **Carchariniformes**  
Two dorsal fins without spines; anal fin present; five gill slits, with the last one to three over the pectoral fin; gill rakers absent; eyes with nictitating fold or membrane; spiracles present or absent  
*Examples: hammerhead, requiem, catsharks*
Order: **Lamniformes**

Two dorsal fins, without spines; anal fin present; five gill slits, last two may be above pectoral fin; spiracles usually present, small and behind eyes; eyes without nictitating membrane; mouth extending well behind eyes.

*Examples: white shark, basking shark, mackerel shark*

![Shark Images]

Order: **Orectolobiformes**

Two dorsal fins, without spines; mouth very short, confined to being well in front of eyes; nostrils specialized, with prominent nasoral grooves with barbels in most; spiracles below the eye except in *Rhincodon*; many with small gill slits and with fifth slit overlapping the fourth behind the origin of pectoral fin.

*Examples: Nurse shark, whale shark*

![Shark Images]

Order: **Squaliformes**

Two dorsal fins, with or without spines; anal fin absent; five gill slits; spiracles present; nictitating lower eyelid absent. Many species are known from deep water and *Centropus* is known from over 6,000 m.

*Example: dogfish shark*

![Shark Images]

Order: **Rajiformes**

Gill openings ventral; anterior edge of the greatly enlarged pectoral fin attached to side of head, anterior to the gill openings; anal fin absent; eyes and spiracles on dorsal surface; nictitating membrane absent, body generally strongly depressed; jaws protrusible in most; teeth pavementlike; in most, water for breathing taken in chiefly through the spiracle rather than the mouth (except for those living off the bottom); most give birth to live
young (some have eggs encased in a horny capsule); the snout may function as an
electroreceptive organ (as may be true for all elasmobranchs).

Examples: skates, stingray, eagle ray

Grade: Teleostomi  (“Osteichthyes” -- Bony Fishes)
Class: Sarcopterygii  Lobe-finned fishes

Order: Lepidosireniformes
Pectoral and pelvic fins filamentous, without rays; scales small; air bladder (lungs)
paired; larvae with external gills; adults estivate in dry season.
Example: African lungfish

Order: Coelacanthiformes
Evolutionary line of lobe-finned fishes that gave rise to tetrapods. Dorsal fins, each
with a single proximal skeletal element; first dorsal fin sail-like, the membrane supported by
bony spines or segmented fin-rays; second dorsal fin, anal fin and the paired (pectoral and
pelvic) fins with a muscular basal lobe projecting from the body and containing several
cartilaginous or bony skeletal elements. Notochord a well-developed, thick-walled tube filled
with fluid in adult
Example: Coelacanth

Class: Actinopterygii
largest group of fishes, comprising all of the ray-finned fishes.

Order: Polypteriformes
Rhombic ganoid scales; dorsal fin consisting of 5-18 finlets, each with a single spine
to which is attached one or more soft rays; a pair of gular plates, no branchiostegals;

Example: Bichir
Order: **Acipenseriformes**
    Caudal fin heterocercal; gulars absent; skeleton largely cartilaginous
    *Examples: sturgeon, paddlefish*

![Sturgeon and paddlefish drawings](image)

Order: **Semionotiformes**
    Body and jaws elongate; mouth with needlelike teeth; heavy ganoid scales, about 50-65 along lateral line; dorsal fin far back, with few rays; three branchiostegal rays
    *Example: gar*

![Gar drawing](image)

Order: **Amiiformes**
    Caudal fin abbreviate heterocercal; dorsal fin base long, with about 48 rays; large median gular plate
    *Example: Bowfin*

![Bowfin drawing](image)

**Division Teleostei:** Advanced Bony Fishes

Order: **Osteoglossiformes** – bony tongues
    Parasphenoid and tongue bones usually with well-developed teeth and forming a shearing bite; either large eyes or weak electric sense; primarily freshwater, mostly tropical and nocturnal
    *Example: elephant-nose fish, bonytongues*
Subdivision: **Elopomorpha**
Leptocephalus larvae adapted for open ocean existence; numerous branchiostegal rays; marine ~650 spp.

**Order Anguilliformes**
Pelvic fins and skeleton absent; pectoral fins and girdle absent in some; dorsal and anal fins confluent with caudal fin (caudal fin rayless or lost in some); scales usually absent or, if present, cycloid and embedded; body very elongate (eel-like); gill openings narrow
*Examples: American eel, conger eel, moray eel, snake eel*

**Order: Elopiformes**
Pelvic fins abdominal; body slender, usually compressed; gill openings wide; caudal fin deeply forked; scales cycloid; gular plate well developed (median); Leptocephali small
*Examples: tarpon, ladyfish*

**Order: Saccopharyngiformes** gulper eels
Highly aberrant fishes, lacking symplectic bone, opercular bones, branchiostegal rays, scales, pelvic fins, ribs, pyloric caeca, and swim bladder; caudal fin absent or rudimentary; gill openings ventral; dorsal and anal fins long; jaws and hyomandibular greatly elongate
*Example: gulper eels*

Subdivision: **Clupeomorpha**
Otophysic connection (diverticula of swim bladder extends into cranium, ending near inner ear [compare to Weberian ossicles of ostariophysans]). Bony scutes on ventral side; modified branchial apparatus for filter feeding. Most marine; commercially important.

**Order: Clupeiformes**
parasphenoid teeth absent; no leptocephalous larvae. Most are plankton feeders, with long and sometimes very numerous gill rakers that serve as straining devices
*Examples: menhaden, shad, anchovies, herrings*
Superorder: **Ostariophysi**

Largest group of primary freshwater fishes; Weberian ossicles connect swim bladder to inner ear; alarm substance (Schreckstoffe) in skin; many possess abdominal pelvic fins, barbels and electric organs. Primarily freshwater; worldwide ~5000 spp.

Order: **Characiformes**

Teeth usually well developed (most are carnivores); adipose fin usually present; body almost always scaled; pelvic fin present (with 5-12 rays); lateral line often decurved, sometimes incomplete; pharyngeal teeth usually present, but not usually specialized

*Examples: pirana, freshwater hatchet fishes*

Order: **Cypriniformes**

Kinethmoid present (a median bone between ascending processes of premaxillae); pharyngeal teeth opposed to enlarged posterior process of basioccipital bone (which encloses the dorsal aorta) rather than to upper pharyngeal elements, upper jaw usually protractile; always toothless; adipose fin absent; head almost always scaleless; three branchiostegal rays

*Examples: minnows, carp, suckers, loaches*

Order: **Siluriformes**

Sympletic, subopercular, basihyal and intermuscular bones absent; parietals fused to supraoccipital; mesopterygoid reduced. Many other reduced or fused bones; vomer usually toothed; spinelike rays often present at the front of dorsal (often two spines present, one acts as locking mechanisms for second spine) and pectoral fins; body either naked or covered in bony plates; normally up to four pairs of barbels on head (one nasal, one maxillary and two on chin); most with 17 caudal fin rays

*Examples: sea catfish, banjo catfish, armored catfish, NA catfish*
Order: Gymnotiformes
Body eel-like (compressed or rounded; pelvic girdle and fins absent; dorsal fin absent; anal fin extremely long; caudal fin absent or greatly reduced; restricted gill openings; anal pore under head or pectorals; electric organs present;
Example: South American knifefishes

Superorder: Protacanthopterygii

Order: Esociformes
Maxilla toothless; maxilla in gape of mouth; no adipose fin; dorsal and anal fins posteriorly located; no breeding tubercules; no pyloric caeca;
Examples: pikes, pickerels

Order: Salmoniformes
Distribution: Northern Hemisphere, but widely introduced in cold waters for sports and aquaculture. Many are anadromous, spending part of their life at sea, but returning to freshwater where all species spawn in a gravel bed in rivers or streams; most fish die after spawning. Small cycloid scales. Gill membranes reaching far forward, detached from isthmus. Axillary process on pelvics. Last three vertebrae directed upward. No spines. Adipose fin present. Attains 1.5 m (maybe 2 m) maximum length. Highly valuable in sport and commercial fisheries.
Examples: trouts and salmons

Neoteleostei

Order: Stomiiformes
Luminescent organs (photophores) present; chin barbel in some; premaxilla and maxilla in gape of mouth – both with teeth; mouth extending past eye in most; scales if present, cycloid and easily lost; pectoral, dorsal and adipose fins absent in some; ventral adipose fin present in some; branchiostegals 5-24;
Examples: deep-sea hatchetfish, bristlemouths

Order: Aulopiformes
gill arch specialization – second pharyngobranchial arch greatly elongated posterolaterally – unique among teleosts
Example: green-eyes, lizardfishes
Order: **Percopsiformes**

Pelvic fins, if present, behind pectorals and with 3-8 soft rays; spines usually present in dorsal fin; many with ctenoid scales; premaxilla nonprotractile.

*Examples: pirate perch, trout perches*

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Order: **Ophidiiformes**

Pelvic fins, when present, inserted at level of preopercle or farther anterior, and occasionally with a spine; base of dorsal and anal fins long, extending to and usually joining caudal fin; nostrils paired on each side.

*Example: cusk eels*

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Order: **Gadiformes**

Pelvic fins, when present, inserted below or in front of pectorals; no true spines in fins; most with long dorsal and anal fins; scales usually cycloid; premaxilla forms entire margin of upper jaw, protractile in some

*Example: cods*

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Order: **Batrachoidiformes**

Body usually scaleless; head large with eyes more dorsal than lateral; mouth large and bordered by premaxilla and maxilla; pelvic fins in front of pectorals, with one spine; three pairs of gills; branchiostegals 6; swim bladder; no pyloric caeca.

*Example: toadfishes*

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Order: **Lophiiformes**

First ray of spinous dorsal, if present, on head and transformed into illicium (line) and esca (bait), a device for attracting prey to mouth; pelvic fins, if present, in front of pectorals; gill opening small, tubelike at or behind pectoral fin base.

*Examples: anglerfish, batfishes*

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Order: **Mugiliformes**

No direct articulation between pelvic girdle and the cleithra

*Example: mullets*
Order: **Atheriniformes**

Usually two dorsal fins, the first, if present, with flexible spines; anal fin usually preceded by a spine; lateral line absent or very weak; parietals usually present.

*Example: silversides*

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Order: **Beloniformes**

Lower caudal fin lobe with more principal rays than the upper lobe. Presence of a fixed or nonprotrusible upper jaw.

*Examples: flying fishes, halfbeaks*

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Order: **Cyprinodontiformes**

Branchiostegal rays 3-7; pelvic fins and girdle present or absent; upper jaw bordered by premaxilla only, protrusible; vomer usually present and supracleithrum always present; metapterygoid usually absent and ectopterygoid always absent; parietals present or absent; vertebrae 24-54. Marked sexual dimorphism with the males often brightly colored.

*Examples: killifishes, live bearers*

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Order: **Gasterosteiformes**

Branchiostegal rays 1-5; body often with armor of dermal plates; mouth usually small. About 19 species are restricted to freshwater, and another 40 species are found in brackish water.

*Examples: pipefishes, seahorses*

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Order: **Scorpaeniformes**

Head and body tend to be spiny or have bony plates; pectoral fin usually rounded, membranes between lower rays often incised; caudal fin usually rounded (occasionally truncate, rarely forked).

*Examples: sculpins, rockfishes, scorpionfishes*
Order: **Perciformes**

Largest order of fishes. Most families in many suborders are not currently definable in terms of shared derived characters and thus may not be monophyletic. Most perciforms are marine shore fishes (3 out of 4 marine species are in this order), while about 2,000 species (e.g. cichlids) normally occur only in freshwater, and about 2,200 species occur in freshwater for at least part of their life history.

Suborder: **Percoidei**  examples: sunfishes, temperate basses, sea basses, drums

Suborder: **Labroidei**  examples: cichlids, wrasses

Suborder: **Scombroidei**  examples: tunas, mackerels, barracudas

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Order: **Pleuronectiformes**

Adults not bilaterally symmetrical, with one eye migrating to the other side of the cranium; dorsal and anal fins with long bases, body highly compressed, somewhat rounded on eyed side and flat on blind side; About four species probably occur in freshwater, while another 20 species that are normally marine occasionally enter freshwater.

*Examples: left-eye flounders, right-eye flounders, soles*

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Order: **Tetraodontiformes**

No parietals, nasals, or infraorbitals, and usually no lower ribs; posttemporal, if present, simple and fused with pterotic of skull; hyomandibular and palatine firmly attached with premaxilla; scales usually modified as spines, shields, or plates.

*Examples: puffers, triggerfishes, mola mola, boxfish, cowfish*