What is "FISH"?

**JAWLESS**
Cartilaginous

**JAWED**
Cartilaginous  Bony

---

**Part 1 - ANATOMY**

**GENERAL ANATOMY OF FISHES**

Lampreys
Elasmobranchs  Shark+skates
Bony fish

**GENERAL ANATOMY - LAMPREY**

- No jaws – oral disk - suck
- No real bones
- No scales
- No paired fins
- No paired nostrils
- 7 external gill slits

**source: Wikipedia**

**GENERAL ANATOMY - SHARK**

- Cartilaginous skeleton
- Strong jaw
- Scales - placoid
- 5-7 gill openings
- One or two dorsal fins
- Heterocercal caudal fin

**source: Wikipedia**
GENERAL ANATOMY – BONY FISH

1. operculum (one gill opening), 2. lateral line, 3. dorsal fin
4. fat fin, 5. caudal peduncle, 6. caudal fin, 7. anal fin
8. photophores, 9. pelvic fins (paired)
10. pectoral fins (paired)

bony skeleton + fins supported by spines and rays, paired fins, scales


ADAPTATION & MODIFICATION OF FINS

Perciformes Remora
Perciformes Tuna
Aulopiformes tripodfish
Loaches
Bichir - Polypterusformes

FIN MODIFICATIONS

„Sucking disc“ based on anatomical changes of fins

E – Gobiesocidae
F – Gobiidae

POSITION OF PELVIC FINS

A – abdominal sturgeon
B – subabdominal
C - thoratic perch or bass
D - jugular cod

Important taxonomical character
**TYPES OF CAUDAL FIN**

Based on asymmetry

- **F** - heterocercal sturgeon
- **G** - heterocercal bowfin
- **H** - homocercal Sea bass
- **I** - isocercal Cod

**Recent fishes**

**FISH SKELETON**

Iori Tomita

By proper preservation and staining of fish we can gain transparent fish body with all bones visible.

**FISH SKELETON**

"SKULL"

**SKULL OF BONY FISH**

Important novelty of modern teleost – protrusion of mouth

- **Primitive fishes**
- **More recent fishes**

**SKULL AND FEEDING**

ANIMACE video
PHARYNGEAL TEETH

- Structure of the Moray's pharyngeal jaws

SKIN & COLORATION

- Body of fishes is mostly covered by scales
- Mucous glands on skin produces mucus as protection of the skin
- In epidermis are chromatophores – colour of the skin
  - Chromatophores – pigment-containing cells
  - Melanophores – black, dark brown
  - Xanthophores – yellow and orange
  - Erythrophores – red
  - Iridocyty – guanin - silvery
- Xanthophore pigmentation – ornamental fish, golden fish
- Albinism - absence of pigments – light coloration

SCALES

1. Placoid - sharks
2. Cosmoid - lungfish
3. Ganoid - bichir, sturgeon
4. Cycloid + Ctenoid - teleostei
MUSCULAR SYSTEM

"quick" white muscle (pike)
"slow" red muscle (tuna)

DIGESTIVE SYSTEM

INTERANAL ORGANS

CIRCULATORY SYSTEM

Part II - PHYSIOLOGY
**BREATHING - GILLS**

Water - high density and viscosity, low oxygen content.

Gills: the best way to gain oxygen (O2) from an environment where its concentration is already very low.

Counter-current circulation permits O2 to diffuse from high to low concentration, even across venous tissue after most O2 has been removed from the water by gills.

**BREATHING OF ATMOSPHERICAL OXYGEN**

ACCESSORY BREATHING ORGAN

- Skin – Anguilla (Eel)
- Intestiny – cobitis, misgurnus (loaches)
- Labyrinth – clarias (catfish), beta (labyrinth fish - Osphronemidae)
- „Lungs“ - lungfish

**OSMOREGULATION**

Osmosis: movement of water through a membrane from an area of high concentration to area of low concentration.

Osmolarity: total moles of solute per liter of water.

1. Isoosmotic: 2 solutions have same osmolarity.
2. Hypoosmotic: solution with higher H2O concentration.
3. Hyperosmotic: solution with lower H2O concentration.

**ARE THEY DRINKING WATER?**

Freshwater teleost

Marine teleost

**BUOYANCY**

1) Esocidae (physostomous)
2) Cyprinidae (physostomous)
3) Percidae (physoclistous)
**SENSES - SIGHT**

- Lens of fish is spherical.
- Lens has variable optical density.

**SENSES - SIGHT**

- Anableps anableps

**SENSES - SIGHT**

- Deep sea adaption of *Macropinna microstoma*, transparent head

**SENSES - SIGHT**

- Deep sea adaption of *Dolichopteryx longipes* – mirror organ.

**MIRROR ORGAN**

- Weber’s organ – connected with gas bladder
- It is an anatomical structure that connects the swim bladder to the auditory system - transmitting auditory signals (ossicles) straight from the gas bladder.
- It is typical character of Ostariophysi - the second-largest superorder of fish.
**SENSES - TASTE**

- Sensors in the mouth, pharynx, on the operculum, barbels

**SENSES - SMELL**

**SENSES - TOUCH**

- Neuromasts on the body – head, lateral line

**SENSES – ELECTRIC FIELD**

- Catfish
- Torpedo
- Elephant fish (mormyridae)
- Eels

**BODY SHAPE**

**MOTION**

- Swimming of individual
- Swimming in school
Part III - ONTOGENY - ECOLOGY

SEXUAL DIMPORPHISM

Different coloration

Different size of male and female - cavity for the eggs

Different thickness of the skin in sharks – male bites female

SEXUAL DIMPORPHISM

Extrem in deep sea fishes:
Tini miniatuarezid males, attached to female body

REPRODUCTION

Cartilaginous fish (chimaera, shark)
Internal fertilization
A few eggs or vivipary

Bony fish (gold fish, tuna, …)
• External fertilization
• Many eggs – roe (caviar)

Reproductive traits and life-history patterns

Mating systems:
– Promiscuous - both sexes with multiple partners - mostly
– Polygynous - males with multiple mates (cichlids)
– Polyandry - females with multiple mates – few (Anglerfish, males “parasitize” females, clownfish)
– Monogamy - mating pair remains together over time, long gestation of young (some cichlids, seahorses, pipefish)

Various types of parental care:
• Cichlids
• Catfishes
• Seahorse - Syngnathidae

• Chondrichthyes
• Bony fish
**LIFE CYCLE**

**Egg:** Trout eggs have black eyes and a central line that show healthy development. Egg hatching depends on the water temperature in an aquarium or in a natural habitat.

**Fingerling and Parr:** When a fry grows to 2-5 inches, it becomes a fingerling. When it develops large dark markings, it then becomes a parr.

**Alevin:** Once hatched, the trout have a large yolk sac used as a food source. Each alevin slowly begins to develop adult trout characteristics.

**Fry:** Button-up occurs when alevin absorb the yolk sac and begin to feed on aquatic insects.

**Juvenile:** In the natural habitat, a trout avoids predators, including wading birds and larger fish, by hiding in underwater roots and brush.

**Adult:** In the adult stage, female and male Tasmanian Rainbow Trout spawn in autumn. Trout turn vibrant in color during spawning and then lay eggs in fish nests, or redds, in the gravel.

**Egg:** Trout eggs have black eyes and a central line that show healthy development. Egg hatching depends on the water temperature in an aquarium or in a natural habitat.

**Egg hatching** depends on the water temperature in an aquarium or in a natural habitat.

**Alevin:** Once hatched, the trout have a large yolk sac used as a food source. Each alevin slowly begins to develop adult trout characteristics.

**Fry:** Button-up occurs when alevin absorb the yolk sac and begin to feed on aquatic insects.

**Juvenile:** In the natural habitat, a trout avoids predators, including wading birds and larger fish, by hiding in underwater roots and brush.

**Adult:** In the adult stage, female and male Tasmanian Rainbow Trout spawn in autumn. Trout turn vibrant in color during spawning and then lay eggs in fish nests, or redds, in the gravel.

**SCALES & AGE**

We can count annual rings on hard structures such as scales, otoliths, vertebra...

Many of fishes grow continuously, many of fishes can live for decades and reach up to a few meters in size… …biggest are around 18 m (*Rhincodon typus*).

**SIZES OF FISHES**

*Schindleria brevipinguis* 7 – 8 mm, 1 mg

*Rhincodon typus* 12 – 18m, 20 - 30t

**MIGRATION - ANADROMOUS**

- Salmonids (trout, salmon,..)

**MIGRATION - CATADROMOUS**

Sizes of eel larvae according to place of catch
FOOD AND FEEDING

FISH FEEDING - FUNCTION

- Herbivores
  - < 5% of all bony fishes, no cartilaginous fishes
    - browsers - selective - eat only the plant
    - grazers - less selective - include sediments
- Detritivores
  - 5 - 10% of all species
  - feed on decomposing organic matter

FISH FEEDING - FUNCTION

- Carnivores
  - zooplanktivores
  - benthic invertebrate feeders

FISH FEEDING

- Carnivores, cont.
  - fish feeders
    - active pursuit
    - stalking
    - ambushing
    - luring

DIFFERENT FEEDING

- *Epibulus insidiator* – extreme protrusion

Similar to Darwin’s finches, different shaped mouths permit specialization on many prey items.
THANK YOU FOR YOUR ATTENTION