ANATOMY, PHYSIOLOGY & ECOLOGY OF FISHES

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What is „FISH“

JAWLESS

JAWED

Cartilaginous

Bony

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Part I - ANATOMY
GENERAL ANATOMY OF FISHES

Lampreys

Elasmobranchs
Shark+skates

Bony fish

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

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

Pelvic and pectoral fins are paired
Reproduction organ of male
Developed senses

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

(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)

Fish form and function show a high degree of variation.
ADAPTATION & MODIFICATION OF FINS

Perciformes
Remora

Perciformes
Tuna

Aulopiformes
Tripodfish

Siluriformes

Loaches

Marlin

Bichir - Polypteriformes
“Sucking disc” based on anatomical changes of fins

E – Gobiesocidae  F - Gobiidae
FIN MODIFICATIONS

Modification allowing to fly…
POSITION OF PELVIC FINS

Important taxonomical character

A – abdominal
sturgeon

B – subabdominal

C - thoracic
perch or bass

D - jugular
cod
TYPES OF CAUDAL FIN

Based on a/symmetry

Primitive fishes

F - heterocercal
  sturgeon

G - heterocercal
  bowfin

H - homocercal
  Sea bass

I - isocercal
  Cod

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

SHARK

BONY FISH
SKULL AND FEEDING

Important novelty of modern teleost – protrusion of mouth

• Primitive fishes

• More recent fishes

ANIMACE video
PHARYNGEAL TEETH

[Images of pharyngeal teeth and anatomical structures]

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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
SKIN & COLORATION

- **Chromatophores** – pigment-containing cells
- **Melanophores** – black, dark brown
- **Xanthophores** – yellow and orange
- **Erythrophores** – red
- **Iridocyt** – 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

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(a) Cartilaginous fishes

- Spiracle
- Mouth ventrally located
- Gill slits
- Pectoral fin
- Dorsal fins
- Anal fin
- Pelvic fin
- Tail (caudal fin) heterocercal: upper lobe longer than lower lobe
- Placoid scales

(b) Bony fishes

- Dorsal fins
- Mouth usually terminal
- Operculum (gill cover)
- Pectoral fin
- Pelvic fin
- Anal fin
- Tail (caudal fin) homocercal: upper lobe about equal in length to lower lobe
- Cycloid or ctenoid scales
„quick“ white muscle (pike)
„slow“ red muscle (tuna)
INTERANAL ORGANS

GONADS

KIDNEY
Part II - PHYSIOLOGY
CIRCULATORY SYSTEM

One circuit

Double circuit
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 O\textsubscript{2} 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 $H_2O$ concentration.
3. **Hyperosmotic**: solution with lower $H_2O$ concentration.
ARE THEY DRINKING WATER?

Freshwater teleost

Marine teleost

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BUOYANCY

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

Lens of fish is spherical

Lens has variable optical density

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• Anableps anableps
SENSES - SIGHT

- Deep sea adaption of *Macropinna microstoma*, transparent head
Deep sea adaption of *Dolichopteryx longipes* – mirror organ.
MIRROR ORGAN -

1. a. Secondary retina
   b. Reflective crystal

2. c. Lens
   d. Retina

Weber’s organ – connected with gass bladder
It is an anatomical structure that connects the swim bladder to the auditory system - transmitting auditory signals (oscciles) 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

incurrent  
naris  
excurrent  
naris

A

water
flow

folds of sensory olfactory epithelium
- 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 DIMORPHISM

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 miniaturezid 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)
REPRODUCTION

• Chondrichthyes

• Bony fish
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
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.

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

**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.

**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.

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LIFE CYCLE

- Adult
- Eggs
- Alevin (fry with yolk sac attached)
- Fry
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 (*Rhyncodon typus*)
SIZES OF FISHES

*Schindleria brevipinguis* 7 – 8 mm, 1 mg

*Rhincodon typus* 12 – 18m, 20 - 30t

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MIGRATION - ANADROMOUS

- Salmonids (trout, salmon,..)

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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, \textit{cont.}
  - fish feeders
    - active pursuit
    - stalking
    - ambushing
    - luring
Similar to Darwin’s finches, different shaped mouths permit specialization on many prey items.
DIFFERENT FEEDING

- *Epibulus insidiator* – extreme protrusion

[Video link](http://kzr.agrobiologie.cz/)
THANK YOU FOR YOUR ATTENTION