

OSMOREGULATION AND EXCRETION

Two systems are closely related to each other.

Kidneys;

Removes some of the metabolic waste

Assists in the Discharge and retention of mineral salts

Gills;

Clean the blood,

Extraction of nitrogenous materials,

Discharge and retention of various ions

Intestine and skin

Kidneys:

Located on the dorsal wall of the body cavity, located outside the peritoneum

Generally in pairs

Sometimes it can be a single piece (exm:Salmonidae)

Dark red or light brown

Most of the bony fish

- Anterior (Head kidney)
- Posterior (Caudal kidney)

Malpighian body (Renal capsule)

Glomerulus: It is a tuft of capillaries separated from the dorsal aorta.

Bowman's Capsule: The glomerulus is nestled inside a cup-like sac located at the end of each nephron

Kidney tubules (Tubes)

OSMOREGULATION

Due to the transition takes place from the low density to the high density,

The blood of freshwater fish is hypertonic compared to the environment.

Water entering into the body is much in freshwater

Freshwater fish must balance the excess water and must be throw it as urine

FRESHWATER FISH DOESN'T DRINK WATER

Body fluid and blood hypertonic ← Water hypotonic

Marine fish

Body fluid, blood hypotonic → environment hypertonic
Water loss occurs from gills and skin

SEAWATER FISH DRINK WATER

(Marine fish have plenty of seawater in the stomach)

Water passes into the blood and the excess is excreted from the kidneys
Less amount of the urine

When freshwater fish species compare with seawater fish species ;

- Nephrons show more vascularity.

- The number of glomerulus is high. (10,000 <)

- The kidney is larger in freshwater fish.

NERVOUS SYSTEM

Even the most primitive fish has a typical vertebrate nervous system

Nervous system;

Central nervous system (Cerebral spinal cord)

Peripheral nervous system (Cerebrospinal nerves)

Autonomic nervous system (Sympathetic and parasympathetic nervous system)

Brain;

Anterior Brain

Mid-brain

Posterior Brain

Dorsal view of the brain
in Carp

Ear

It is balance and hearing organ

There are no outer and middle ear parts in the fish

There are **INTERIOR EAR - LABYRINTH** parts.

There is no cochlea in the ear. **That's why fish has been known as deaf for many years.**

Labyrinth;

Have half circle channels and otolith organs.

(Sensory cells are available and It is filled with endolymph)

Human's ear hears 20-20,000 Hz

Fish sensitivity is below 1000 Hz (Hearing is quite limited in fish species)

REPRODUCTIVE SYSTEM

Generally sexual dimorphism, rarely hermaphroditism are seen in fish

Ovary

Usually 2 in number, rarely 1.

25% of body weight, up to 70%

Granular appearance

Testes

They are usually double in freshwater fish

Size varies according to breeding season (12% of body weight)

During the breeding season in adult fish (White color, homogeneous and no capillaries)

EGGS

The fertilized egg has a fertilization stain.

Incubation time is different (if the water temperature increases, hatching duration decreases or vice versa)

5 ° C 82 days, 10 ° C 41 days

**THE HATCHING TIME OF THE EGGS IS RELATED TO
TAKEN TOTAL HEAT DEGREE DURING THE
INCUBATION**

CARP $20\text{ °C} / 100\text{ °C} = 5\text{ days}$

LIFE STYLE IN FISH

SEDENTER AND DIADROMOUS (MIGRATOR) FISH

The **sedentary** fish species spend their lives in a certain environment and have very limited migration.

Ex. Crane

DIADROMOUS fish, migrate like birds

Migration;

From the seas --- to freshwater (**ANADROMOUS**) (Exm. Salmon and Shad)

From Freshwater --- to sea (**CATADROMOUS**) (Exm. Eel and Mullet)

AGE DETERMINATION IN FISHES

SCALES (Scalimetri method)

It can be applied to the fishes having **cycloid** or **ctenoid** scales.

Fish growth is reflected in scale growth. Circuli are widely spaced in warm seasons when fish growth is rapid, and closely spaced in cold seasons when it is slow. The outer edge of a series of closely spaced circuli is generally taken to be the end of growth for that year and this point is referred to as the year mark or annulus. The age of a fish is determined by counting the number of annuli or year marks.

DETERMINATION OF AGE WITH OTOLITHES

AGE DETERMINATION WITH OPERCULUM

DETERMINATION OF AGE WITH BONE PARTS

Age determination can be made by comparing the body length and size of fishes between same age ranges

COLLECTING THE FISH SAMPLES

USING EQUIPMENT AND METHODS CHANGE ACCORDING TO THE FISH SPECIES AND SUBSPECIES

COLLECTING THE FISH SAMPLES;

Trammel net

Gill net

Cast net

Hand-Scoop Nets

Fishing Rod

Hunting with electricity

Fyke net

Stake net and Traps

TRAMMEL NET

Consists of **three layers of net**. A slack, **small mesh**, inner panel of netting is sandwiched between two outer layers of netting, which are taught and have a **larger mesh size**.

Trammel nets are used
to catch demersal,
benthic and pelagic
species.

GILLNET

The fish does not see the net, A gillnet catches fish by their gills.

Used in lake and dams and sandy waters with flat floors

It is particularly used to capture small fish

SEINE NETS

A seine is a very long net, with a bag in the centre, it is operated with two (long) ropes fixed to its ends

Center of the net is marked with colored floats

This net can be used for collecting benthic fish as well as pelagic fish as it is pulled through bottom of the sea ground.

THROW NET

It is round and can be different mesh sizes

There is a 3-4 m. rope at the center to collect the net.

It can be used stony ground where other nets do not work

Hand-Scoop Nets:

It is mounted on a stick and usually made with 50 cm. diameter 1x1cm mesh nylon net fixed on round- iron frame.

FISHING ROD:

More used in sport fishing

It is also used in scientific studies from time to time.

Spoon Rod

Feather Rod

Simple Rod (hook worms)

HUNTING WITH ELECTRICITY

Usually used as a generator

The generator produced a low intensity electric current and that is transferred into the water with a 75-100 meters rubber wire

The people holding them walk opposite the direction of flow

FYKE NET

It consists of cylindrical or cone-shaped netting bags mounted on aluminum rings. It has wings which guide the fish towards the entrance of the bags.

Entering fish can not get out of the same place is trapped

Suitable for catching fishes of nightlife (Exm: Eel)

TRANSMISSION TO THE LABORATORY

Live fish should be transported for Bacterial, Viral and Parasitological examination

If the laboratory way is not far distance;

Fishes are kept alive with oxygen in the aquarium or tanks until the examination .
(If this period is too long, some ectoparasites are lost.)

If the laboratory way is far distance and dead fishes are transported

Cans filled with ice

In refrigerator (connected to the car battery)

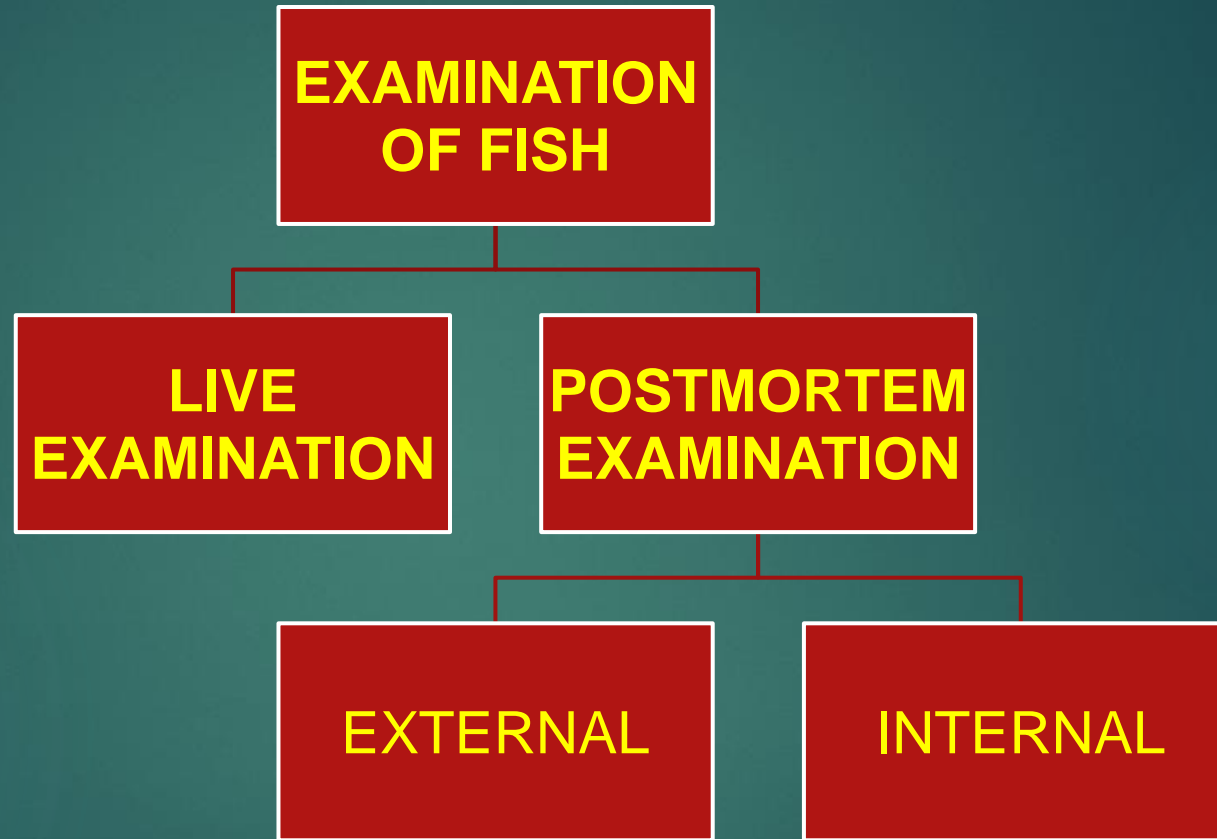
If these are not possible it can be transported in a fixing solution.

Fixing material; 4% formol, 70% ethyl alcohol, 1% Propylene Fenoxatal are the most widely used chemical agents

If the samples are longer than 30 cm. 40% formol should be injected into the abdominal part and anal opening.

70% spirit, 80% NaCl, 100% vinegar can be used for detection if other substances are not available

EXAMINATION OF FISH



- **IN LIVE EXAMINATION**

- Swimming is controlled.

- Wobble while swimming?
- On the water surface or on the bottom?
- Steady?
- Does it turn?
- Does it jump out of the pool or aquarium?

- Feeding is controlled.

- Does it interested in eating?
- Is the feed intake reduced?

- Respiratory movements are examined.

- Gill movements?
- Is its mouth open on the surface of the water?

- Relationship with the environment.

- Does it respond to various stimulus?

Postmortem Examination

A) External

B) Internal

A) External

- Body disorders, development status and general appearance are evaluated.
- Overweight x Slimming
- Skeletal disorders
- Anomaly
- Tumoral formations
- Abdominal swelling
- Change in the fins
- Redness, swelling of the anus
- Stitching, shedding of fish scales
- Examination of the head
- Skin changes
- Gills examined

WET MOUNT PROCEDURES

- To make a tissue squash, excise a small (approximately 8 mm³) piece of tissue and place it on a slide with a drop of water or normal saline. Place the edge of the plastic coverslip near the tissue and then gently squash it. Examine the tissue architecture under low (100x) magnification and look for parasites and granulomas. Examine it at (400x) magnification to identify protozoa and bacteria.

*It is much better to perform **skin and gill examination before euthanasia**. (It may be decreased ectoparasite number because of using chemical agents for euthanasia)

- If there is a visible **ectoparasite** on the skin, it is collected with a fine forceps or brush and **placed in 70% alcohol or 5% formol**.

- Then, with the edges of a cover glass, it is **scraped** from the **back, lateral, and fins** and the preparation is prepared by microscopic examination with its own wetness. Between the slide and coverslip

- Then, with the edges of a cover glass, it is **scraped** from the **gills**, and the preparation is prepared by microscopic examination with its own wetness. (wet mounth)

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- **EUTHANASIA**

- Fish killing;
- **Carbon dioxide** narcosis followed by gill cut
- Percussive blow (Stunning) followed by gill cut
- **Decapitation** followed by either pitting or exsanguination
- **Stunning** followed by either decapitation or exsanguination
- **Chemical agents** such as MS 222, Tricaine, Benzocaine, 2-phenoxyethanol, sodium penthobarbital, carbon dioxide and Quinaldrine can be used.
- **Electric current** can be used.
- Examination may be performed **with sedation, but** it should be noted that ectoparasites will leave from the body if chemical agents use.

B) Internal examination and Culturing:

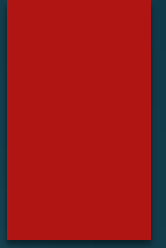
USING VENTRAL APPROACH

- A. After euthanasia, the **flank** is **swabbed** with antiseptic, avoiding the anus and any skin lesion
- B. **The body wall is cut with sterile scissors**. Care is taken to **avoid the anus** and to cut **close to the body wall** to prevent severing the intestine.
- C. By **removing the skin**, the internal organs are exposed..
- D. **Culture material is taken** from kidney and other **organs**. It is also possible to take a piece of organs and place them in a sterile ependorf to freeze and store for later examination.

Common Lesions Found in the Viscera

- Aquarium fish are often **overfed**, resulting in excessive accumulation of fat in the peritoneal cavity. **The liver may be pale yellow** because of lipidosis.
- **Fluid accumulation** in the abdomen (dropsy) can result from **infection by viruses, bacteria or parasites**.
- Examination of abdominal fluid may reveal bacteria or parasites.
- **Ascitic fluid** may also form from **osmoregulatory dysfunction**. **Hemorrhages** in the viscera can be caused by **systemic viral or bacterial infection**.
- Chronic inflammatory diseases such as **mycobacteriosis, which is the most important chronic disease, can affect virtually any internal organ**. **Granulomas produced by this pathogen** must be differentiated from neoplasia, from foreign body reactions produced against protozoan or metazoan parasites and from melanomacrophage centers.
- **Melanomacrophage centers** are usually solid foci of cells that have varying amounts of pigment. While these are common in healthy fish, they **increase in number with chronic stress**. In contrast to melanomacrophages, granulomas are usually multilayered structures having a central zone of necrotic debris. This **necrotic center is the most useful feature for identifying granulomas**.

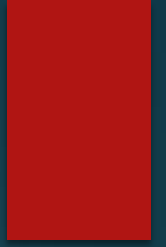
Brain is superficially similar to those of mammals. Microscopically, it appears grey-White organ.



Intestine: The intestinal tract is usually the first organ seen when the peritoneal cavity is opened. However, body fat is most commonly deposited in the peritoneal cavity and may obscure the viscera. The intestine should be opened after the other viscera have been examined to reduce contamination by bacteria and other organisms.

The Pancreas: like most glands, is usually not grossly visible

Liver: is a brown to red-brown in the anterior portion of the peritoneal cavity. Microscopically, normal liver has a homogeneous appearance; an occasional melanomacrophage center may be seen.



Spleen is a bright red to black organ located in the mesentery. Microscopically, normal spleen has a reticulated appearance because of the network of elipsoids that are the sites of blood filtration.

Gonad In immature fish, the reproductive organs are ribbon like, grey-white or yellow strips that usually lie just ventral to the swim bladder. Sex can often be determined by examining a wet mount (It can be seen sperm or follicles) In some fish that are ready to spawn, the ovaries may occupy most of the peritoneal cavity and cause gross abdominal distension.

Kidney is a retroperitoneal organ that is functionally divided into two segments. The anterior kidney is the primary site of hematopoiesis. It has the consistency of bone marrow. The posterior kidney has renal excretory tissue

DIAGNOSTIC USEFULNESS OF DIFFERENT TISSUE PRESERVATION TECHNIQUES FOR IDENTIFYING FISH PATHOGENS

- *The diagnostic usefulness of the postmortem examination is highly dependent upon the quality of species. Whenever possible, live fish should be examined.
- *Fish decompose much more rapidly than mammals under similar conditions; this is especially true for small fish.
- *Most ectoparasitic protozoa and Monogenea die within minutes to hours of host death, depending on temperature and parasite species.
- *Secondary bacterial invasion of both skin and internal organs occurs rapidly after death, making interpretation of culture results difficult.
- *If submitting live fish is not an option, animals can be put in a plastic bag and placed on wet ice. If fish cannot be submitted within several hours, euthanized fish should be frozen immediately.

Diagnostic usefulness of different tissue preservation techniques for identifying fish pathogens.

Specimen	Protozoan ectoparasites†	Monogenean ectoparasites†	Metazoan parasites (except monogenea)†	Myxozoa and microsporea†	Viral isolation	Bacterial isolation	Gene probe‡	Antibody Probe or histologic value
Live fish	+++	+++	+++	+++	+++	+++	+++	+++
Dead fish ¹	-	-	++	++	+	-	-	-
Iced fish ²	+	++	+++	+++	++	+	+	+
Frozen fish ³	+	+	++	++	++	++	+++	+
Fixed fish ⁴	++	+	+	++	-	-	+++	+++

¹Dead fish left in water at room temperature for 6–12 hr.

²Live fish placed in a plastic bag on wet ice for 6–12 hr.

³Live fish placed in a plastic bag frozen at -20°C.

⁴Tissues from a live fish immediately placed in 10% neutral buffered formalin.

+++ = best; - = virtually useless.

AFTER CULTURING:

- Organs were examined macroscopically and microscopically; Are the internal organs anemic? Hyperemic?
- Are there any internal bleeding, nodules, tumor-like formations, fat deposition, enlargement?
- During the autopsy, the leaked blood drawn through a pipette from the peritoneal cavity and the blood taken from the heart with the syringe are transferred onto the slide and examined.
- Prepared the wet mounts from the small pieces of tissue taken from the liver, spleen, kidney and pancreas
- The gall bladder is opened in a petri dish and its content examined by microscope

If there is any **parasite in the peritoneal cavity**, it is collected and examined

Is there any **color change in the reproductive organs**? Are there any bleedings? Are there abnormal growths? Examined.

The **digestive tract opens from the esophagus to the anus**. If there are **parasites** or similar structures, they are collected with a forceps or a brush (5% formol-70% alcohol). Is there mucus or blood in the intestine content? After the content is taken, Is the **general appearance of the mucosa hyperemic or bloody**? Examined.

- **Muscle examination**: Cross sections are performed at various locations . Is there any **color change, bleedings, nodules**? Examined. If it is necessary prepared wet mounts from muscles.

- **Removed the brain from** the head and . prepared wet mounts from brain.