Output 8: Learning resources for Fish Anatomy

Introduction

The learning resources in this guide have been designed to support ‘short episodes’ of focussed learning’ on a specific topic within the Fish Anatomy section following the Recognition of Prior Learning (RPL) using the multiple-choice question sets. Each episode has a title and number that relates it to a specific multiple-choice question or questions within the subject area.

The resources cover the identification of healthy external and internal features and their structure and function. The aim is to provide experienced husbandry operatives with enough information, insight and understanding of the basics of Fish anatomy, so as they can identify the external and internal anatomical structures and know their basic function.

The multiple-choice questions and learning resources have been designed to satisfy the level of knowledge and understanding prescribed by the Scottish Aquaculture MA level 2 (husbandry operative). In addition to the learning episodes there is an interactive fish on power point that has been designed to help learners to relate structure to function as they self-study.

The RPL/APL system is designed for experienced work-based learners with some knowledge, as well as knowledge gaps who wish to ‘fast track the assessment and accreditation of their knowledge.

(See spread sheet guide to Scottish Optimal RPL and follow up through guided self-study learning)

Recommended pedagogy for RPL/APL

Step 1- Undertake multiple choice questions for the section

Step 2 Automated RPL to determine which questions have not been answered correctly in full

Step 3 (a) Automated documentation and QA of correct responses for submission for accreditation of specific knowledge

Step 3 (b) Self -study guided by the RPL results and feed back

Step 4 Second Multiple Choice (MC) with alternative question (same topics and level) or complete alternative approved summative assessment leading to accreditation.

(Note: Alternative MC questions will need to be developed by the VET user as only one set is available from the optimal project.)

Using these resources

The multiple-Choice questions can be presented by Rapid Response technology via hand-held devices or presented within a Virtual Learning Environment, which is the recommended method for independent work-based learners.

A well designed VLE with high level assessment functionality and grade book will allow the full automation potential of the system to be gained, as well as supporting communication with tutors, farm supervisors and peers.

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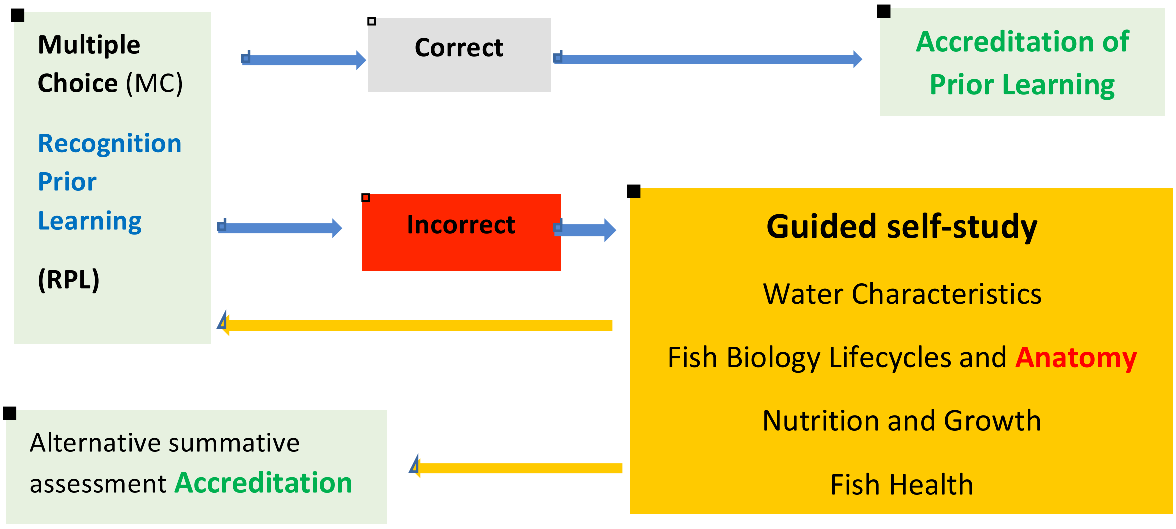
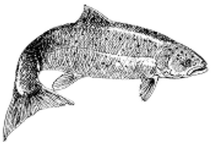


Graphic to illustrate recommended RPL/APL pedagogy for experienced work-based operatives

B21 **Fish Anatomy**



Function of fins

The fins in fish are vary in their size, shape, structure and location on the body, according to their function. Some fins have a single, unique function, others perform similar functions, and a small minority number appear to have no function at all! It is important to note that all fins can be controlled, moved and folded, apart from the adipose fin in salmonids. They are often used to perform their specific function simultaneously with other fins, enabling the fish to move, control its direction, or maintain its position in the water column.

The number of fins and their position on the body will vary according to the species. Some of the fins are paired and most are supported by fin rays (bony structures), but each fin type will perform the same function.

Dorsal fin

What are the functions of each type of fin?

Dorsal fins - the number and location of the dorsal fins varies between species, but the main function remains the same. The dorsal fin has fin rays and is located on the back of the fish. Its main function is to prevent rolling and yawning and help the fish to maintain an upright position when swimming.

Pectoral fins – the pectoral fins have fin rays which are paired and are located close to the head in all fish species. They have a wide range of movements like the pelvic fins, including turning right and left, braking and raising and lowering in the water column.

Anal fin

Pelvic fins – the pelvic fins have fin rays which are paired and not always located in the same area of the body in all fish species. For example, in salmonids they are in the abdominal area, whereas in perch they are located closer to the head near the pectoral fins. They have a wide range of movements like the pectoral fins, including turning right and left, braking and raising and lowering in the water column.

Anal fins – the anal fin has fin rays and is located immediately behind the vent in all fish. Most fish will have one anal fin, but some marine species such as Atlantic cod will have up to three anal fins. The main function of the anal fin is like that of the dorsal fin, to prevent rolling and yawning and help the fish to maintain an upright position when swimming.

Caudal (tail) fin – the caudal fin has fin rays and is located at the rear end of all fish species. This is a single fin with a main function of

Adipose fin

providing propulsion for forward motion.

Adipose fin – the adipose fin is a small fatty fin with no fin rays, found only in salmonid species e.g. salmon and trout. It appears to have no real function.

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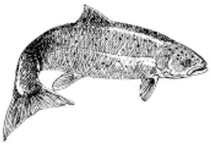


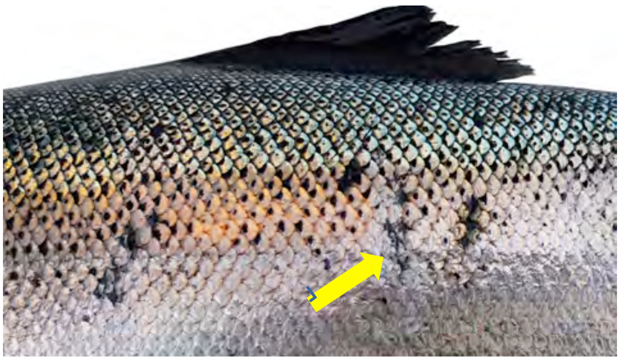
Lateral line

The lateral line is sometimes referred to as a fishes sixth sense. It a structure which is usually visible as faint lines of pores running lengthwise down each flank, from the vicinity of the gill covers to the base of the tail.

Structurally, the lateral line is a hollow fluid-filled tube with pressure sensitive canals used to detect vibrations and changes in water pressure. It has several important functions. First and foremost, it can allow the fish to detect dangers that may not be immediately visible and helps it to swim and maintain its position in the water, even if blind.

Does the lateral line have any other functions?

Lateral lines also serve an important role in schooling behaviour as well as body orientation and the avoidance of predators. Predatory species will use their lateral line system to detect water displaced by fleeing prey, helping them to more accurately target their attack. In some species, the receptive organs of the lateral line have been modified to function as electroreceptors, which are organs used to detect electrical impulses. Most amphibian larvae and some fully aquatic adult amphibians possess mechanosensitive systems comparable to the lateral line.



Lateral line

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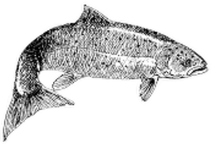


Nares

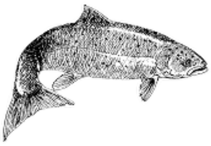
Most fish have two nares (nostrils) located at the front of the skull. They are not connected to their respiratory system. The nares are blind ended sacs lined with sensory nerves which allow the olfactory organ to detect chemicals in the water at low levels. This provides fish with the ability to find food. For some bottom feeding species such as eels and catfish their sense of smell can be well developed and more important that sight for food detection.

Nares

Do the nares serve any other important functions?

Although salmonids are visual feeders, their nares are very important. This structure gives them a well-developed sense of smell with the ability demonstrated by migratory salmonids to return to their river of their birth. Their well-developed sense of smell helps them navigate. On returning from the north Atlantic feeding grounds and traveling the coastline, they can sense the unique chemical odour of the river they originate from. In the closing stages of the journey, they can usually detect the actual nursery stream where they grew in to parr after hatching and emerging from the spawning redds.

B29 **Fish Anatomy**



Fish eyes

The eyes in fish are located on the side of the head which gives each eye an independent and wide angled field of view. Some of the more predatory species have a limited amount of binocular vision due to a slightly more forward placement of the eyes which allows them to work together in judging distance when attacking prey.

Eyes

The structure of the eye in salmonids is basically the same as a mammalian eye although in salmonids the iris is fixed and so has no influencing in regulating the amount of light entering the eye, whereas in most mammals the iris controls the diameter and size of the pupil and thus the amount of light entering the eye to the retina. In salmonids focus is maintained by moving the lens close to and further away from the retina, whereas in mammals focus is achieved by changing the shape of the lens in the eye.

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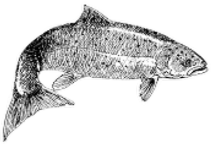

Gills

It is obvious that fish must 'breathe' oxygen somehow to sustain life but can't obtain their oxygen in the same way as terrestrial mammals. Rather than breathe as we would, fish absorb oxygen by diffusion from the water through delicate, well protected structures called the gills.

The gills primary function is to absorb oxygen. But they also fulfil other important functions, including; excreting ammonia and carbon dioxide and helping the fish maintain the concentration of their internal fluids. This vital process is called osmoregulation.

Why is osmoregulation so important?

Osmoregulation is necessary because of osmosis.

The effects of osmosis are as follows; in freshwater the salt balance in the fish is higher than its external environment. This allows water to enter the fish via semi-permeable membranes. The kidney in freshwater fish removes this excess water and discharges the excess as dilute urine, thereby performing an essential 'osmo-regulatory' function.

In saltwater the opposite occurs as fish internal body fluids are of a lower concentration than the external environment. Fish drink constantly to regain water lost by osmosis to prevent dehydration and an excessive concentration of their bodily fluids. Any excess salts brought in with the saltwater are discharged by the chloride cells on the gill and removed by the kidney and discharged as concentrated urine.

How are the gills designed to abstract dissolved oxygen?

The gill filaments (primary lamellae) are a red colour due to the rich blood supply. If the primary lamellae are examined closely there are smaller structures called secondary lamellae, which have a large surface area over which the water passes. As the water passes over the gill surface, oxygen is absorbed into the blood stream, while carbon dioxide and ammonia are discharged. Oxygen and metabolic wastes move in and out as the result of 'diffusion gradients' allowing substances to cross the lamellae membranes from high to low concentrations.

Delicate gill lamellae are protected by an operculum

How are the gills protected?

in all fish the gills are located close to the head, and in most protected by a cover called the operculum. This works like a pump in response to the fishes' mouth movements constantly bringing water across the surface of the gill. The actual gills are feathery filaments supported by a bony structure called a gill arch with tooth like structures on the edges called gill-rakers which protect the delicate gills from external damage.

Maintaining healthy gills in farmed fish stock is a major part of the management of fish health and welfare, as the blood rich tissues are prime sites for attack by parasites and pathogens.

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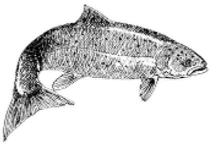
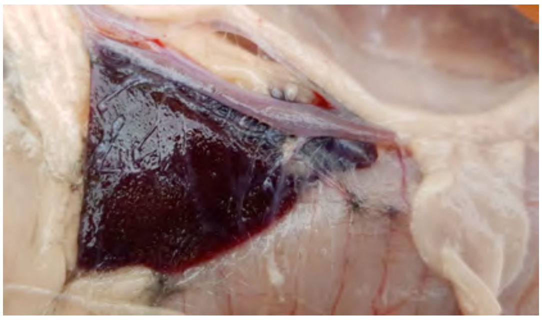


Internal organs producing blood cells

The blood cells (red and white) both have a limited life span and so must be continuously recycled and replaced. There are several organs and tissues in the fish involved in the production of blood cells.

What are the primary blood cell producers?



Spleen

The primary blood cell producers are:

Spleen – recycles, produces and stores blood for use in times of need e.g. bleeding due to injury

Kidney – the front kidney produces red blood cells while the rear kidney cleans the blood by removing nitrogenous waste to discharge as urine, and excretes water through osmoregulation

Heart – will produce blood, but its primary role is to pump blood to gills and around the body. The heart located near the head and gills, pumps deoxygenated blood initially to the gills via the ventral aorta and the branchial arteries. Once the blood has been oxygenated it is pumped around the body within a single pass circulatory system, through arteries (away from the heart), capillaries (through the tissues) and veins (back towards the heart).

Liver – will recycle and produce blood cells but its primary role is to clean blood, produce bile and store, synthesise and maintain chemicals and sugar levels in the blood

What else does the liver do?

The liver is a large red/brown coloured organ with a smooth surface found in the anterior (front) part of the body cavity. Similar to many other animals the liver fulfils a range of additional functions including:

- Storage of nutrients such as vitamins, minerals and glycogen (sugar) for use in the blood as energy
- Manufacture of proteins
- Manufacture of the alkaline digestive juice bile (stored in the gall bladder)

Liver (paler in farmed than wild fish)

- Removal of metabolic wastes and toxins from the blood.

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Swim bladder

Most fish species (but not all) possess a swim bladder which provides buoyancy and allows fish to adjust and maintain their position without actively swimming. The swim bladder is sensitive to water pressure, so the fish can constantly adjust as they move through the water column.

What does the swim-bladder look like?

The swim bladder is generally a torpedo shaped structure that normally runs the length of the body cavity immediately beneath the kidney. It can take the form of a single sac as in salmonids, or a dual connected sac as in cyprinid species.

Swim Bladder

How does the swim-bladder function?

The swim bladder in most fish performs the same functions but there are two basic designs:

- Physostomous – connected to the gut and buoyancy can be adjusted quickly. Found in salmonids and cyprinids.
- Physoclistous – no connection to the gut and buoyancy is slowly adjusted through the circulatory system. Found in perch and seabass.

Do all species of fish have a swim-bladder?

Some fish that do not possess a swim bladder are bottom living species. Some flatfish and active species such as sharks and tuna which must constantly swim and expend a lot more energy as a result.

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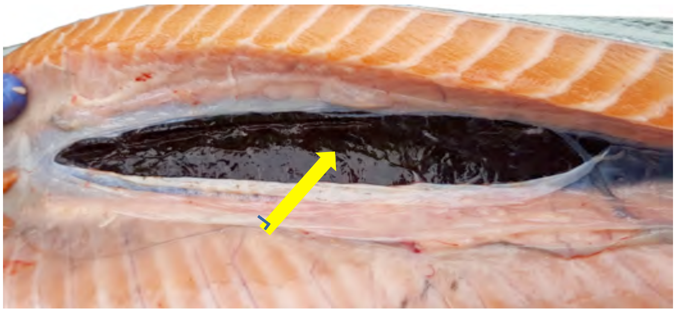
Kidney

All animals will produce waste products following digestion and metabolising for energy and growth. As fats and carbohydrates are processed the waste produced will be in the form of carbon dioxide and water, while protein metabolism will produce nitrogenous waste such as ammonia. When waste products are produced, they are transported by the blood to be discharged from the body.



Kidney

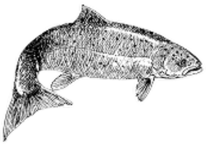
What does the kidney look like?

Although most of the waste will be discharged through diffusion in the gills some will be filtered from the blood in the liver and kidney. The kidney in fish runs the length of the body just beneath the backbone, under the swim bladder. The front and rear of the kidney are a smooth fused single structure and in healthy fish have a dark (in some cases almost black) cherry red colour.

What does the kidney do?

The kidney is the main blood filter, and while the front kidney produces hormones and red blood cells, the rear kidney cleans the blood by filtering nitrogenous waste that is discharged as urine.

The kidneys in fish also play an important part in osmoregulation, helping to maintain a stable concentration of internal body fluids by excreting excess water.

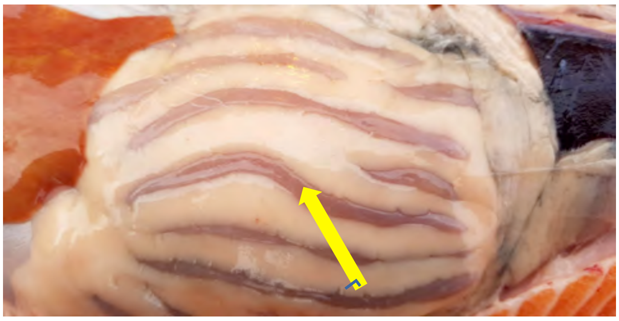


Stomach and Pyloric Caecae

When food is ingested it must go through a process called digestion. The food consumed is broken down into smaller molecules to be absorbed into the fishes' bloodstream to use for energy, body maintenance and growth.

Where does digestion start?

Once food has been ingested, the initial digestion takes place in the stomach which is a muscular u-shaped structure. The stomach stores the food and begins the mechanical and chemical breakdown. The stomach uses muscular contraction to breakdown food and secretes hydrochloric acidic and digestive enzymes from its lining, which reduces the pH to between 2 and 4.

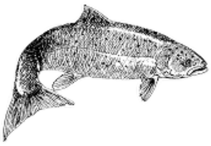


Pyloric Caecae

The environment created in the stomach is strongly acidic and capable of breaking down proteins efficiently. Once partially digested small quantities of the food are passed from the stomach to the intestine via a muscular valve called the pylorus sphincter.

What role do the pyloric caecae play?

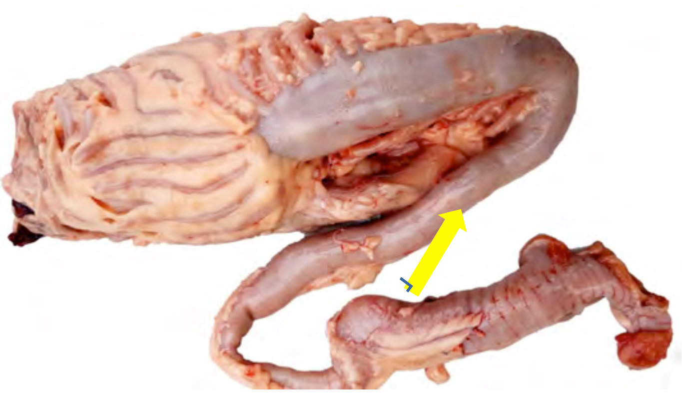
Alkaline digestive enzymes are released (pH 8-9) to continue the breakdown process in the intestine. Some fish, including salmonids, have pyloric caecae which adjoin the upper intestine. Their role is to releases alkaline digestive enzymes. Additional digestive enzymes are also supplied by the gall bladder and the pancreas, which help to further breakdown the products of digestion, so as they can be absorbed into the bloodstream via the intestinal lining and get transported to those parts of the body where required.



Intestine

Once the digestion process has begun in the stomach, small quantities of partially digested food periodically pass from the stomach to the intestine via a muscular valve called the pylorus.

The intestine in fish is not as muscular as the stomach and can vary in length depending on the feeding habits and diet of the fish. In carnivorous species such as salmon and trout, the intestine is less than the length of the fishes' body. Conversely, in herbivorous fish such as some cyprinids the intestine length can be up to nine times the length of the body. This is because it takes a lot longer and for the chemical action to breakdown plant material, than it does to breakdown protein from animal sources. The primary role of the intestine is digestion, but like other structures it carries out a range of functions including assisting the regulation of internal water balance and the endocrine regulation of digestion and metabolism.



Intestine

The primary role of the intestine is digestion and alkaline enzymes are released (pH of 8-9) to accelerate the process. Some fish, including salmonids, have an additional structure attached to the upper intestine which aids digestion. This structure is called the pyloric caecae, which assists the absorption of nutrients and releases alkaline digestive enzymes to aid the breakdown of food.

Additional digestive enzymes are also supplied by the gall bladder and the pancreas, which helps breakdown the products of digestion to smaller constituents that can be absorbed into the bloodstream via the intestinal lining and carried to the parts of the body where they are required.