Your Name

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Course Number

Date

Fish biology: Anatomy and Physiology

**1. Describe the structure and function of the teleost skeleton, cellular bone and the scales. Discuss the similarities and differences in function between scales and bone.**

Answer:

**Teleost Skeleton**

Teleost is the fish group that contains the majority of the cultured fin fishes; teleost fish group is evolutionarily advanced, physically structured, contains multiple subgroups of fishes, and is the member of Teleosti infraclass. The skeleton of the teleost contains the head skull, vertebral column, and fins. The structure of these three parts of the skeleton are discussed below:

Head Skull

The structure of the head skull is suitable to provide necessary protection to eyes, brain, and other sensory organs like nose. It houses all necessary organs, like eyes, and provides shape to the face. It creates buccal cavity that supports the feeding and respiration functions. The muscles that are responsible for the movement of jaws are attached to a point created by the skull. Finally, gills’ housing is created in the form of the opercular cavity by the skull.

Vertebral Column

The vertebral column of teleost has neural spine on both sides of centrum through which the spinal cord passes. It expands throughout the body from head skull to the tail, and creates an elaborate structural frame along with the ribs. The main function of the vertebral column is to support the body from being stretched and shortened due to the contraction of the longitudinal muscles while swimming. It also helps the body cope up with the stresses to which it gets subjected when it swims fast.

Fins

Fins remain at the lower part of the skeleton. Fins are occurred in the body of the teleost in pairs and are mounted on the girdles of pelvic and pectoral areas. The posterior margin of the opercular cavity is formed by the pectoral girdle that is attached to the cleithrum bone. However, this is not the case in lower teleosts, where the pelvic girdles are not connected to the skeleton, but rather are rooted in the ventral muscle. Such structure can be found in case of salmonids. On the other hand, in the case of higher teleosts, the pelvic girdle is attached even in a delicate position, closer to anterior position, against the pectoral girdle. One such teleost is the perch.

The rays of the ventral fins and the single dorsal run the line of the haemal spines and the neural of the backbone. Both spiny and soft types of fin rays are possible. Usually, single bone spiny fins are available in the perch, whereas in case of salmonids (salmon and trout), soft fin rays are seen. In case of clupeids, such as shads, herrings and sardines, fins similar to salmonids are available.

**Cellular Bone**

Bones of the teleost are made of the same cellular and structural components that make the bone structure of mammalian, avian animals, and birds. The structure of the bone may be regarded as composed of an extracellular matrix, and three types of bone cells including the osteoblasts (cells that form the bone), osteocytes (the cells that reside inside the matrix), and the osteoclasts (cells that resorb bones). The growth and remodelling of the bones are controlled by the collective actions of these different cell types during the production, mineralisation, and resorption of the bone matrix. The remodelling of new bone is done instantly because of the continuous small scale operation of osteoblasts and osteoclasts cells on the surface of the bones. The bone mineralisation controlling process may essentially be seen as the mechanisms of endocrine, which performs mobilisation and deposition of phosphate and calcium. In the mineralisation of the bone, every 10 calcium molecules are attached to 6 phosphate molecules. The formula of the major calcium salts in the minerals of bone is Ca10 (PO4)6(OH)2 (chemical name Hydroxyapatite). It is thus obvious that the bone mineralisation process resorbs or deposits phosphate in proportion to calcium.

**Scales**

Scales create a protective layer over the skin of the teleost fish. Scales are sticky, visible, and patterned cover that keep the interior of the fish free from outside impact of the environment and help the fish maintain body temperature inside the water. Scales are calcified plates that have two sides — the outer side consists of rigged bony section and the internal side consists of fibrous connective tissue section that is partly or fully uncalcified. The scale pocket of the dermis provides the housing for scales to grow and the epidermis covers it to provide necessary protection from environmental hazards. Scales develop with the body size; the growth ring in the scales can be used as an age detector as it changes with the age of the fish. One of the major function of scales is to act as the repository of calcium that supplies additional calcium in case of high calcium demands such as during the period of reproduction.

**Similarities and Differences in the Function between Scales and Bones**

Similarities

Both scales and bones support the body structure and provide external outlook to the fish body. Both of these body parts are responsible for keeping the fish steady while swimming. The bones give the fish necessary support and directivity during swimming, while scales help in gliding water around the body to reduce extra pressure. Both the bones and the scales grow with ages and give a good indication of the age of the fish.

Dissimilarities

Bones absorb the calcium to remodel it, while scales supply it in case of higher demand. The role of bones is to provide structural support to the body, while the role of scales is to provide external covering to the body.

**2. Describe the stages in the life cycle of a fish, giving examples of how each stage is reared in an aquaculture system.**

Answer:

Different stages of a fish life follow a sequential pattern, starting from birth to ending in aged death. These stages together make the life cycle of a fish, which, though differing in many perspectives, are followed by the aquaculture system. In its simplest form, the life stages in the life cycle of a fish may be categorized in terms of the nutrient sources. These are:

* Endogenous (at this stage of life, all necessary nutrients are derived from the egg);
* Exogenous (at this stage of life, all necessary nutrients are derived from the external environment);
* Mixed (at this stage of life, some necessary nutrients are derived from the egg while the rest from the external environment).

However, few fishes, grouped as ovoviparous fish, deviate from this general life stage pattern; example of such fishes include aquarium species guppies, platies and mollies. Young lively fishes are bred by ovoviparous fishes that gets all their necessary nutrients from external environmental sources, unlike oviparous fishes that lay eggs contained of all nutrients for the embryo and larva.

The egg, embryo, and larva stages of life are categorized under endogenous, adult, and juvenile; fry is considered to be exogenous stage, and a brief period between larva and fry is considered to be mixed. The following sections provide brief discussion on how different life stages of a fish are cultured in an acculturate system.

**Selection and Conditioning of Broodstock**

Sexual maturity comes with ages, and the age limit is different for different species. Selection of mature fish to conduct intercourse is important. The life cycles of many acculturate breed are synchronised with seasons, which are signaled through seasonal cues like rainfall, temperature or photoperiod. In order to make the breed engage in intercourse, either natural or artificial seasonal cues are provided, which is known as broodstock conditioning.

**Spawning**

Spawning occurs as the fishes receive signals from hormonal changes in the body or seasonal cue. In case of aquaculture, spawning is a major challenge, because in many cases it is not possible to create appropriate signal for fishes to make them lay their eggs. Human intervention is essential to provide seasonal cue either naturally or artificially, or to give hormonal injection to bring necessary bodily changes. However, in some cases, spawning occurs naturally in aquaculture breed, while in few cases, early stages are captured from the wild, or adult are cultured as spawning is not possible. Japanese amberjack and eels are examples of fishes that are captured from the wild and Atlantic Bluefin tuna is the example of the fishes that are cultured when adult.

**Fertilisation of Eggs**

In nature, egg fertilisation occurs spontaneously. In aquaculture, fertilisation may occur spontaneously in cases where eggs and sperms are not separated. However, if eggs and sperms are separated, human intervention is required to mix them in proper proportions. This is a challenging job if sufficient eggs and sperm are not available, because in case of low sperm count, low fertilisation is resulted, whereas in case of large sperm count, polyspermy may give rise to abnormal embryo.

**Egg Incubation**

Controlling the environment is essential for fertilised eggs in order to provide favourable condition for embryo development. In case of natural fish, fertilised eggs are either developed inside the mother fishes or in a proper place under water selected by the mother. In case of aquaculture, egg incubation is done to maintain appropriate oxygen levels, nitrogen compounds and pH levels, as well as temperature levels. To avoid the growth of pathogens and egg smothering, suspended solid is also controlled during egg incubation process.

**Rearing of Larvae**

During the early larva stage, a fish depends on the nutrients of the yolk sac because it does not develop a functional gut immediately after hatching. As the time progresses, the larva starts consuming exogenous supplies and reduces its dependency on the yolk sac. Soon the yolk sac diminishes as it is consumed up and the larva becomes a fry; during fry stage, it becomes completely exogenous. In an aquaculture, the reading a larva is quite difficult because it involves making the larva accustomed to external food. In order to facilitate external sources of nutrients, culturing appropriate plankton is also a challenging task. However, in case of freshwater fishes, the stage of planktonic larva is relatively small or absent because of the presence of larger eggs that provide more yolk to be consumed until the larva is relatively well developed in the incubation stage. Larva rearing for such species is easier.

**Rearing Fry**

Naturally, a fry undergoes many developmental phases, during which it becomes young and gains competency to accommodate itself to the changing environmental conditions. In aquaculture, fry rearing stage extends to the point when the fry grows out adequately to support itself. During this period, a fry is given favourable environment with plenty of foods. A young fish is considered to be a fry for the first few months of its development from a larva.

**Rearing Grow-Out**

After a fry become older, it enters juvenile stage and learns how to survive and feed itself. The juvenile fish can adapt to changing environmental condition. In aquaculture system, the juvenile fish is moved to the grow-out facility where it receives enough foods based on its development and growth. The grow-out facility can supply enough food for juvenile fish to avoid predation among them.

**Summary**

The knowledge regarding the life cycle, growth rate and food habit of a species is highly important for successful aquaculture, because providing a favourable environment for growth and reproduction is highly dependent on the knowledge. Some fishes are very sensitive to changes in environment, where the others do grow or reproduce unless favourable conditions are arranged. Therefore, rearing a fish in an aquaculture is a challenging task, the success of which depends on how perfectly artificial environment and management matches with natural environment.

**3. Describe the structure and function of the hypothalamus-pituitary complex in teleost fish.**

Answer

**Structure**

Pituitary gland is situated directly underneath the hypothalamus section of the brain. The gland is consisted of different types of lobes — the anterior lobe and the posterior lobe, known as the adenohypophysis and neurohypophysis respectively. In case of few fishes, the presence of an intermediate lobe can also be seen. A complete neuronal connection exists between the hypothalamus and the posterior pituitary lobe, whereas the connection between the anterior lobe and the hypothalamus is rather complex as it contains both neuronal and blood vessel connection. Such a complex connection forms a local hypothalmo-pituitary portal system for transmitting neural and hormonal signals. However, this connection varies widely across different species.

**Function**

Pituitary gland secretes hormone in response to signals from various sensory organs, which is transmitted to central nervous system to initiate action plan. Hypothalamus is the central integrative section in the brain that processes information transmitted through the hormonal release from the pituitary gland, and controls the further release of hormone. A range of small neuropeptide hormones are synthesised and released through neurosecretion process triggered by the stimulation of hypothalamus. This hormone then controls hormone secretion from the pituitary gland. Another function of pituitary gland is to control hormone secretion from different endocrine glands. Pituitary gland secrets many types of hormones that performs different functions. These hormones include adrenocorticotropic hormone, melanocyte stimulating hormone melanotropin, water balance controlling hormone prolactin, thyroid stimulating hormone thyrotropin, growth hormone somatotropin, and reproduction controlling hormone gonadotropins. These hormones are produced in anterior lobes. Of several posterior lobe hormones reproduction and water balance controlling hormone isotocin and vasoticin are the most important. In case of few fishes that have intermediate pituitary lobes, functions of melanin concentrating hormone and lipid metabolism controlling hormone, somatolactin, are important.