Udai Pratap (Autonomous) College, Varanasi

E-learning Material

Module/Lecture	01
Subject	Zoology
Year/Semester	M.Sc. IV
Unit	I
Topic	Fish Anatomy
Sub-topic	Integumentary System of Fishes
Key-Words	
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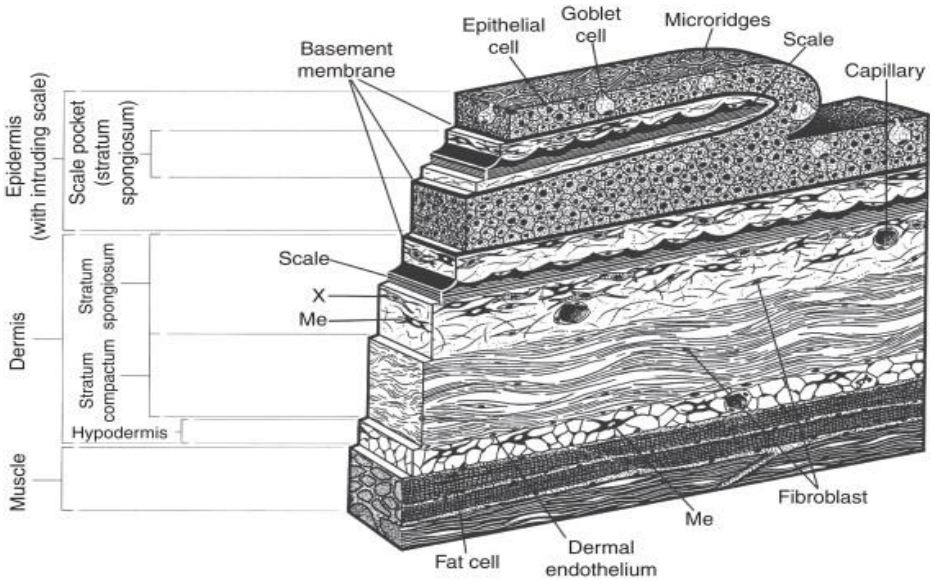
INTEGUMENTARY SYSTEM OF FISH :

Fishes have a more of less smooth, flexible skin dotted with various kind of glands, both unicellular and multicellular glands. Integument of fish is characterized by structures that help the organism which maintain its water balance. Generally characterized by thin epidermis, with little or not keratinized. The integumentary system of a fish resist penetration by infectious bacteria- contributes to laminar flow of water across the surface make a fish slippery to catch from enemy and protection from environment. The integumentary system comprises the skin and its various derivatives, it participates in various metabolic activities to meet the functional requirement of the adult fishes because of its importance as the primary interface between an organism and its environment, the skin is designed to perform many functions. These functions includes-

1. **1.Support and protect soft tissues against abrasion and microbes.**
2. **Reception and transduction of external stimuli i.e. heat, chemical and tactile.**
3. **Transport of materials involved in excretion, secretion, resorption, dehydration, rehydration etc.**
4. **Heat regulation.**
5. **Respiration mechanism.**
6. **Nutrition/Nutrient storage i.e. storage of vitamins, synthesis of vitamin D.**
7. **Locomotion.**
8. **Colouration, Cryptic or display.**



So that integument consists primarily of the skin and its derivatives. Skin is a functional unit composed layers of fairly distinct epidermis (derived from ectoderm) and dermis (derived from the dermatome and somite) that are separated by basement membrane. Integument of various classes of fishes are –

Amphioxus has an epidermis with a single layer of cells. A synapomorphy of craniate is the presence of a stratified epidermis. The horny teeth of Lampreys are made up of Keratin. Most of fishes

have little or no Keratin in the skin. There are 3 major types of hard tissues associated with skin-

ENAMEL :

Enamel the hardest tissue in the body made of hydroxyapatite and has no cells or tubules within it, only about 3 % of its organic fibers. It is ectodermal in origin and is produced by accretion of layers generally it is more superficial of hard tissues and found on teeth and outer layer of denticles, scales and dermal armor, a type of enamel is ganoine.

DENTINE :

Dentine is softer than enamel and has about 25 % organic fibers, usually contains tubules occupied by processes of the mesodermal cells, deep to enamel layer. Some types of dentine are Osteodentine, Orthodentine and Cosmine in which Cosmine is characterized by canals.

BONE :

Bone has about the same level of organic components as dentine may have osteons (Haversian System) as does Osteodentine or may be deposited in layers like Orthrodentine.

AGNATHANS :

The skin of living Agnathans lacks dermal bone or scales, but the earliest craniate fossil (Ostracoderms are known from tiny scales of dermal bone found in the Cambrian period. These scales has-

(1) A deepest thin layer of lamellar bone.
(2) Another layer called dentine.
(3) A surface coat of enamel layer.

There was a pore canal system that likely functioned as electroreception.

CHONDRICHTHYES :

The skin is covered with denticles or placoid scales with layers of dense lamellar bone dentine and enamel. Teeth are modified placoid scales.

BONY FISHES :

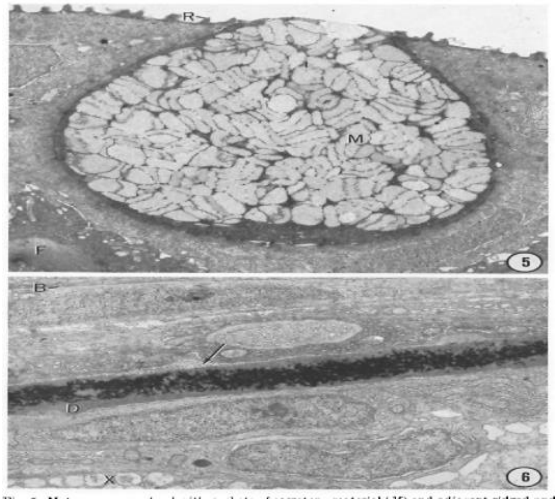
In bony fishes generally a thin epidermis is found with little or no Keratinized cells at the stratum corneum. Mucus secreted from fish skin which seals out water and also prevents invasion by ecto-parasites and fungus composed of three basic compounds, bone, dentine and enamel and bears basal types of scales which includes-

(a) **Ctenoid Scales :** Thin bony scale having comb like process on its outer part and serrate margin.

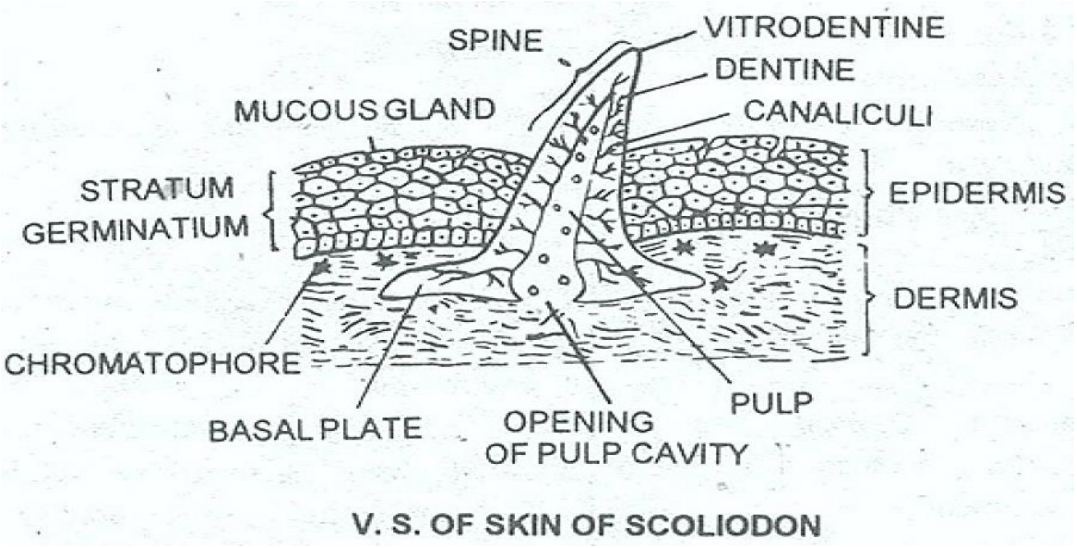
(b) **Placoid Scales :** Scaly out growth of skin that is thicker and more embedded in the skin.

(c) **Cycloid Scales :** Thin bony scale having a smooth surface and rounded margins.

(d) **Cosmoid Scales :** Thick bony plates that are embedded into the skin, that act more like a bony armor.



Goblet cells



V. S. OF SKIN OF SCOLIODON

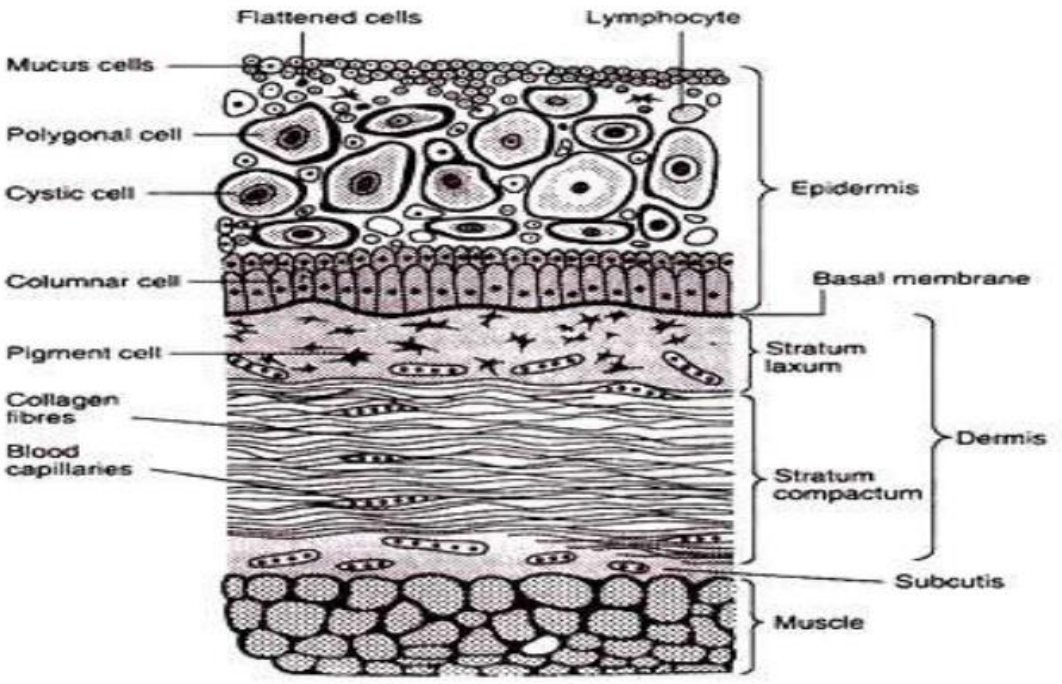


Fig. 3.2 : V. S. fish skin (generalized)

EPIDERMIS :

The epidermis derived from the embryonic ectoderm. The epidermis is a multi-layered epithelium comprising metabolically active and living cells. A superficial stratum corneum, poorly developed or entirely lacking in fishes.

Various modification seen in epidermis it includes unicellular or multicellular mucous producing cells. The epidermal scales are not found in fishes and cyclostomes but tongue of cyclostomes are horny and considered as modified scales.

DERMIS :

Beneath the epidermis, dermis layer is present, it bears connective tissue, blood vessels, nerves and sense organs and is richly vascular and supplies nourishment to the epidermis. The connective tissues are made up of proteinaceous collagen fibers and mesenchyme cells. In ostracoderms the dermal bones are developed and disposed in the form of broad plates covering the entire body but in cyclostomes the dermal bones are absent.

The upper layer of dermis is made by loose connective tissues and known as stratum spongiosum, while the lower layer is occupied by thick and dense connective tissues called stratum compactum. This layer has proteinaceous collagen fibers and mesenchymal cells. The dermis is supplied by blood vessels and provided nourishment to the epidermis.

In dermis scales are embedded which are derivatives of mesenchymal cells. Fresh water catfishes devoid of scales. Some fishes like Paddle fish ***(Polydon)*** in which scales are present in region of throat, pectoral and base of tail. In some fishes scales are modified into teeth. Bony armour plates found in ***Sea Horse*** **(Hippocampus)** and ***Sting Ray*** **(Myliobatoidei)**. In Fresh water Eel (Anguilla) Scales are very small. So deeply embedded on the basis of shape and size. Scales are of four types found in fishes-

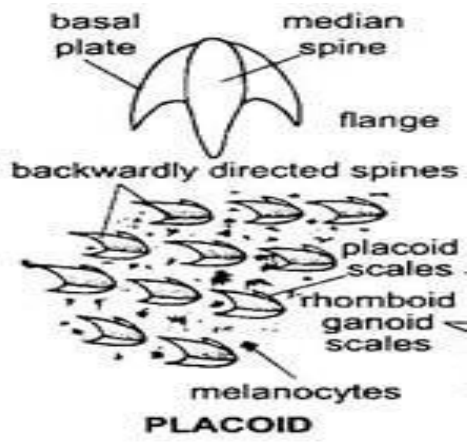
1.PLACOID SCALES :

Placoid scales are found in Elasmobranches (Shark). They are plate like and similar to the denticles of Ostracoderms. They are small dentacles that remain embedded in the skin. Each scale has two parts,

an upper part known as ectodermal cap or spine, this part is made of enamel like substance known as **Vitreodentine**, similar to human teeth.

Another layer of dentine that encloses a pulp cavity follows the vitreodentine. The lower part of placoid scale is a disc like basal plate which is embedded in dermis with cap or spine projecting out through epidermis.

The basal plate has a small aperture through which blood vessels and nerves enter into pulp cavity. The placoid scales are modified in Jaw teeth in Shark, In spine in dorsal fin in Sting ray **(Myliobatoidei)** and in Saw teeth in the ***Pristis***.



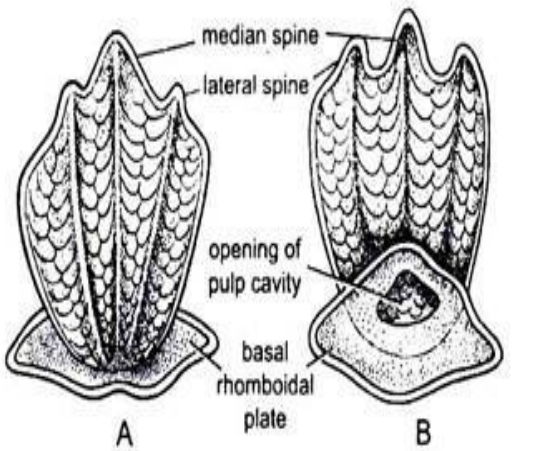


Fig. 14.4. *Scoliodon.* Placoid scales. A–Dorsal view; B–Ventral view.

The placoid scales first appear as small aggregations of dermal cells just below stratum germinativum. Thses dermal cells grow upwards into an arched structure or papilla which gradually pushes the stratum germinativum which work as enamel organ.

Latter on this projecting structure differentiates into spine and basal plate. The outer cells of the papilla known as odontoblasts secrete dentine around the papilla while the central cells do not calcify and constitute the pulp. The mesenchymal cells of the dermis secretes the basal plate. These cells secrete hard cement like structure to cover the basal plate.

2. COSMOID SCALES :

The cosmoid scales are found in living ***(Latimaria)*** and extinct lobe fishes. The cosmoid scales are regarded as direct descendents of bony plates of the primitive ostracoderms. The cosmoid scales is a plate like structure and consists of four or three layers. An outer layer is thin hard and enamel like called vitreodentine. The inner most layer is composed of vascularized perforated bony substance called **isopedine**.

The middle layer is made up of hard non-cellular and a characteristic material called cosmine and is provided with many branching tubules and chambers. The scales are regarded as the precursor of the ganoid, placoid and bony scales of modern teleostes.

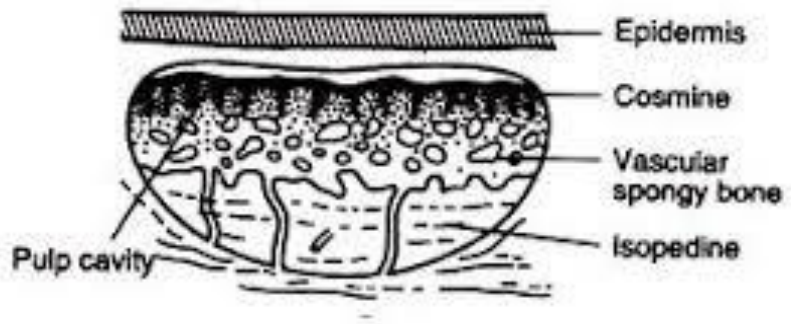


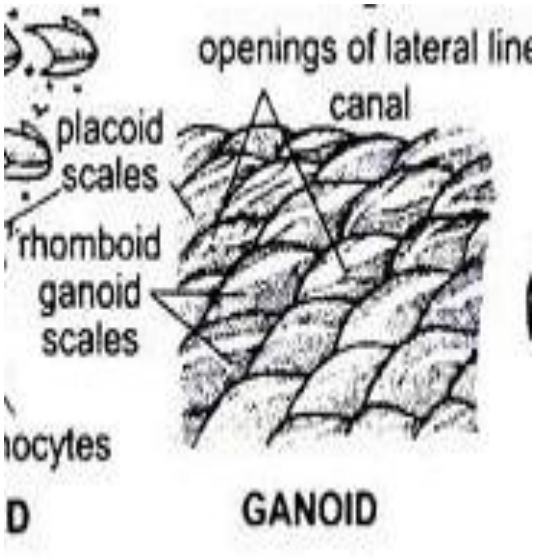
Fig. 3.3(b) : Cosmoid scale (extinct crossopterygians

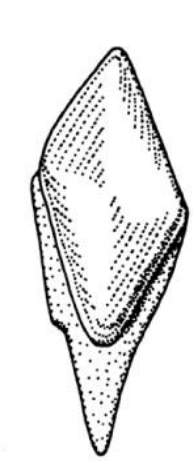
3. GANOID SCALES :

The ganoid scales are thick and rhomboid. They consist of an outer layer of hard inorganic substance called ganoine. The ganoid layer is followed by a cosmine like layer provided with many branching tubules.

A bony layer of **isopedine** occupies the innermost layer. These scales not only grow at the edges but also grow at the surface. The growth takes place by the addition of new layer of isopedine.

The ganoid scales found in ***Polypterus*** and ***Lepidosteius***. In these fishes edge to edge and invest the entire body. In ***Acipencer***, the ganoid scales are modified into large bony scutes arranged into five rwos.





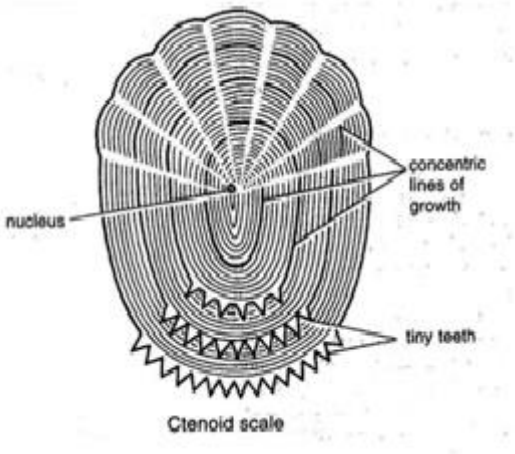
B. Ganoid

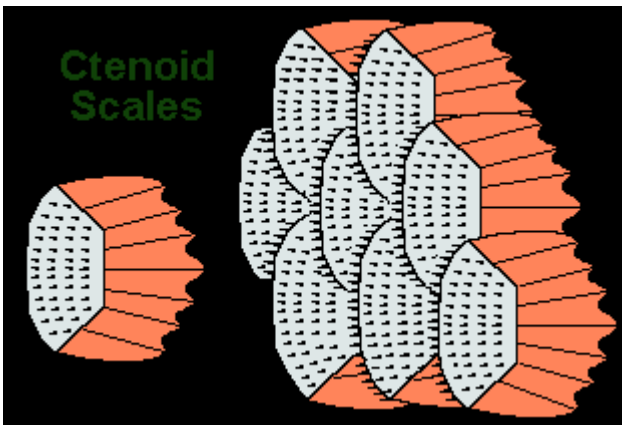
4.CTENOID SCALE :

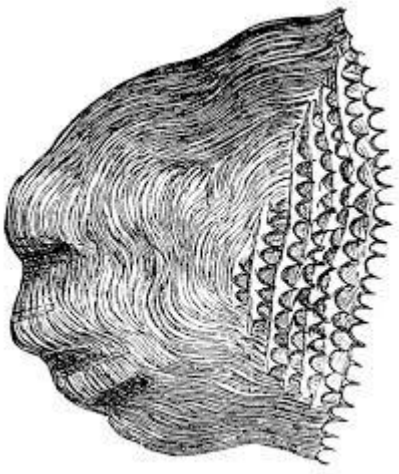
Ctenoid scales are found in spiny rayed teleosts. They are arranged obliquely such a manner that the posterior end of scale overlap the anterior edge of the scale present behind. The chromatophores are present at the posterior part of these scales.

The basal layer forms the bulk of the scale and remains acellular but lacked by collagenous fibers coursing in various directions. Out side of this lies a homogenous surface layer of acelluar calcified material called the bony ridge layer. This layer represent the ancestral isopedin of lepidosteoid type of scale. The ancestral ganoine is absent and its name (Gr ctenos = comb). The bony ridge layer of scales is

scalloped and bears numerous concentric ring like circuli. The circuli arrange concentrically around a central circular zone called focus. During rapid growth the circuli becomes heavy and fall apart. The zone of crowded and fine circuli are known as annuli.



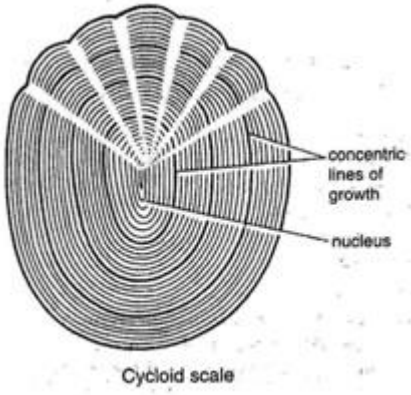


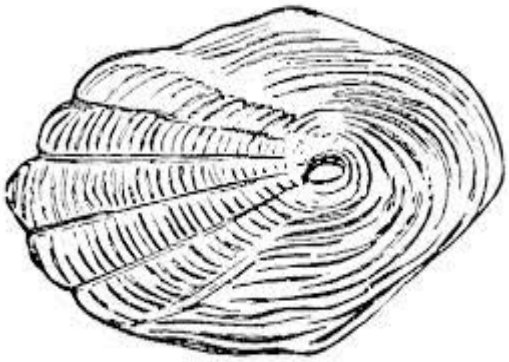


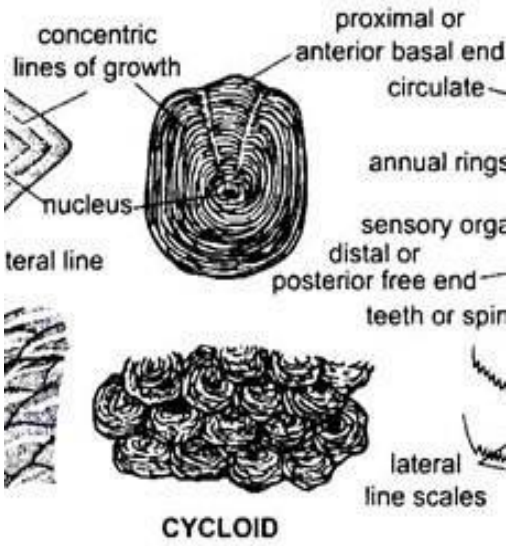
5. CYCLOID SCALES :

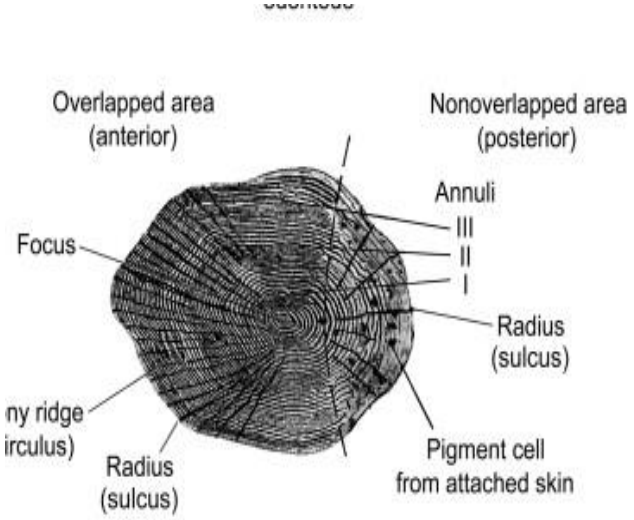
The cycloid scales are devoid of teeth or spines hence seem cyclic. They are found in soft rayed teleosts and modern lobe fineed fishes in ***Micropterus*** have both cycloid and ctenoid scales are found. Cycloid scales are similar to ctenoid scales in all respect except that

they are circular in outline have concentric lines of growth and loosely seated in dermal pockets of fishes.









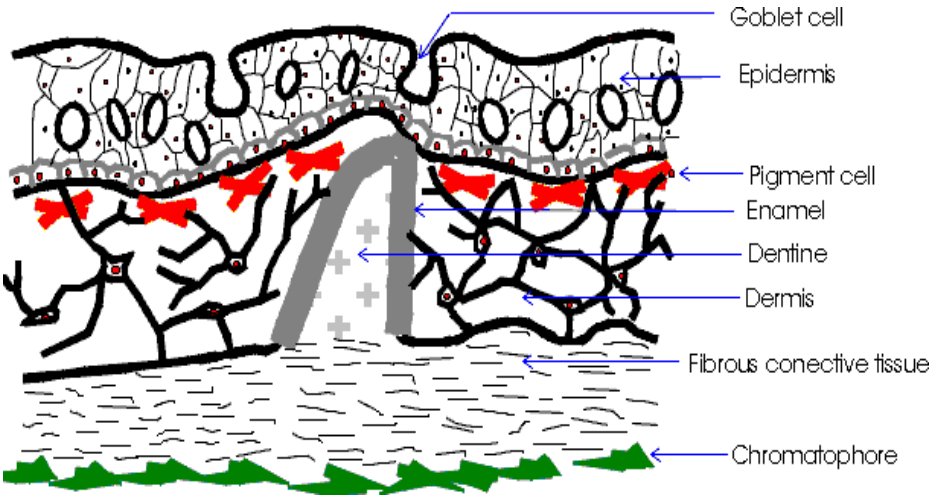
The epithelium of epidermis is modified into a variety of glands, which are-

MUCUS GLAND :

The epidermis is provided with a number of mucus glands, which open at the surface of the skin by minute pores. These glands are flask shaped or tubular extending to the dermis. The mucus glands secretes slippery mucus, which contain a lipoprotein known as mucin.

The slimy mucus reduces drag on fish while swimming in water, continuous secretion and sloughing of mucus wash away micro-organism and irritants which may causes diseases if accumulated. In some fishes, ***Protopterus*** and ***Lipidosiren*** mucus forms a cocoon like structure around the body to avoid dry condition, if weather is hot especially during aestivation. Due to mucus fish emitted a smell as a characteristic odour.

Among fishes, mucus is used for chemical communication. Many teleost feed their young ones on mucus secreted in large quantity on the surface of the body. Some species like ***Macropodus*** and ***Gasterosteus*** use their sticky mucus for preparation of nest for egg laying. Mucus help in regulating to some extent, the osmotic exchange of water and ions between the body fluids and water.



POISON GLANDS :

Many Elasmobranches and other teleost having protective devices in the form of poison glands. These are formed by modification of the multicellular glandular glands which releases a toxic substance to protect themselves from their enemies. Venom or poison glands have evolved in different families of fishes. Actually glandular cells of epidermis are modified into poison glands. The

poison gland are generally present at the base of certain structures like sting, spine of dermal fin and tooth. Poison glands open the tip of these structures to inject poison by penetration into the prey.

The most common E.g. Stingray- which is provided with venomous caudal sting. Chimaeras- has venom glands in the spine of the dorsal fin. The poison glands are present in the grooves of spines of dorsal, pelvic and anal fins of the Scorpion fish ***(Scorpaenidae***) are a family of mostly marine fish that includes many of the world's most venomous species, ***Sturgeon*** fish at caudal peduncles.

PHOTOPHORES :

These glands are derived from stratum germinatium of epidermis. These glands are deeply seated into the dermis and produce light. These light producing luminous organs are mostly found in deep sea elasmobranches and those fishes found in dark zone. The light produced by these glands help fishes to attract the prey and also confuse attention of the predators.

Each gland usually has an apical part, a basal part and a basal layer. The apical part consists of mucus cells that serves to magnify the light produced from basal glandular part of the gland. The basal layer comprises the pigments and blood sinuses lying around the basal part of the gland and acts as a reflecting layer.

Production of light from glandular cells either depends upon the oxidation of a protein- **Leuciferin by an enzyme Leuciferase** or on the **phosphorescent bacteria** living symbiotically in glandular cells of the gland.

PTERYGOPODIAL GLAND :

These multicellular glands are derived from stratum germinatium associated with the Clasper of certain Elasmobranches, their function is not well known.

MUCUS CELLS :

Mucus cells found in cyclostomes, they are two types A small size **goblet cells** and large sized **club or Clavate cells**. **Downing and Novalis (1971)** reported that mucus cells undergo maturation during their migration upwards to the superficial strata.

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Declaration