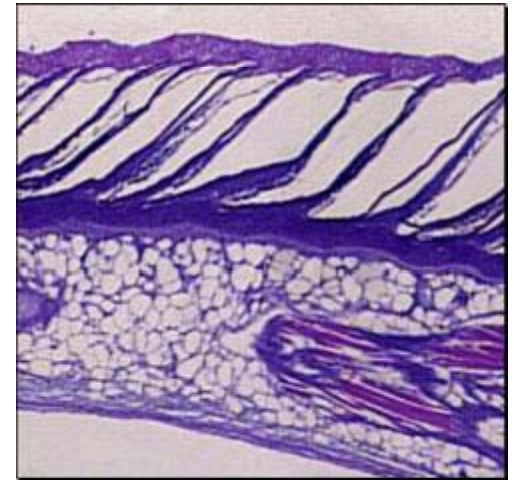


Lecture 5 – Integument - Skin

- Definition : Integument is the boundary between the organism and the environment.
- Skin all over body except fins
- Fish like other vertebrates have two layers of skin
- Outer epidermis and inner dermis



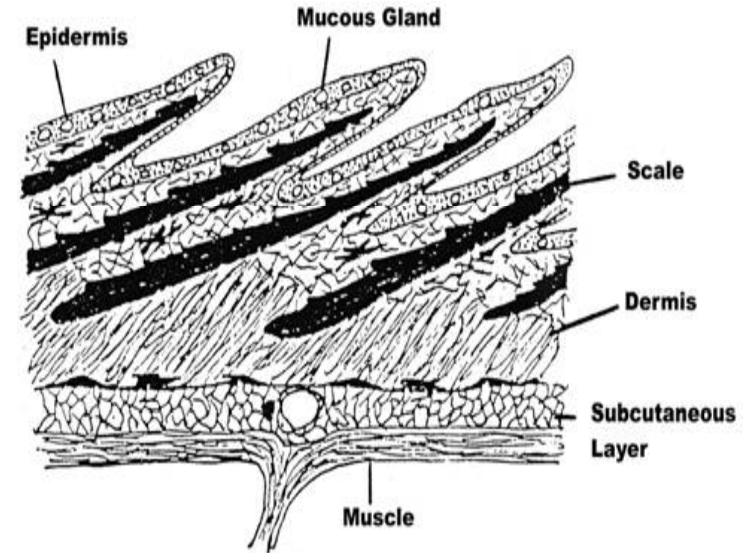
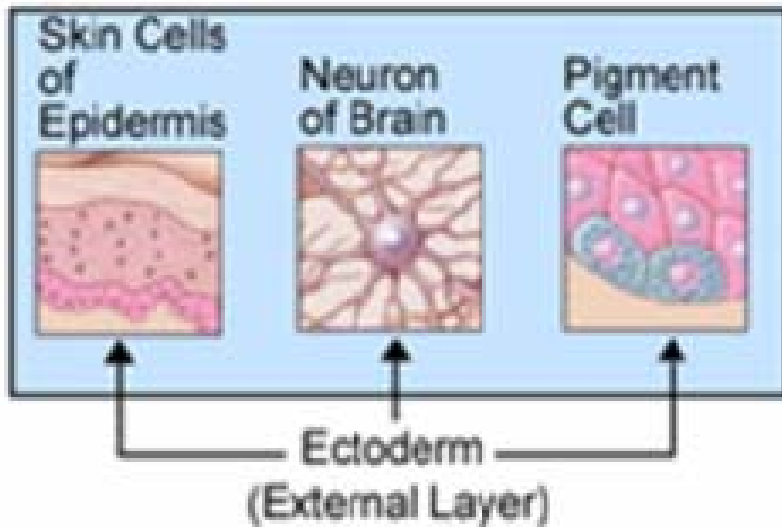
Structure of skin

- The skin of the fish contains an epidermis lacking dead cornified cells and dermis of connective tissue in varying densities.



Epidermis

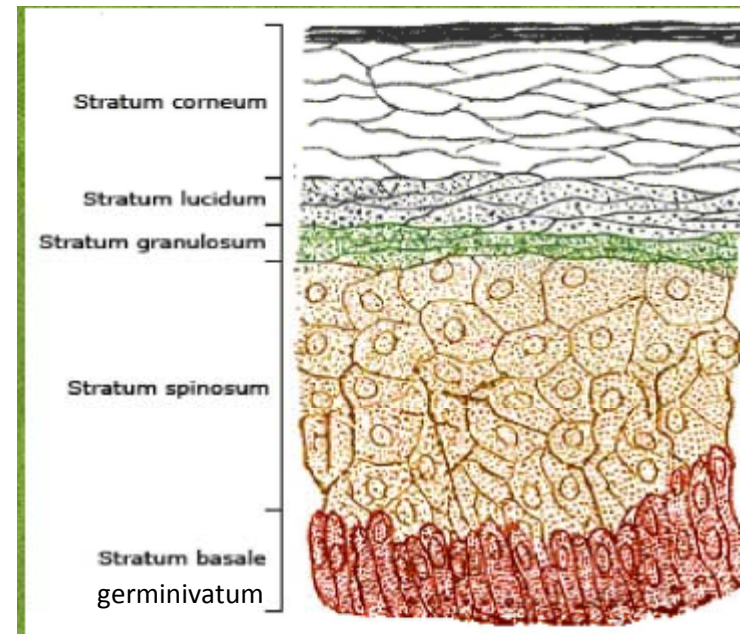
- Ectodermal (outer layer of the embryo) in origin



- Is avascular (contains no blood vessels)
- Contains mucous cells (poison or not)
- Replacement is continuous

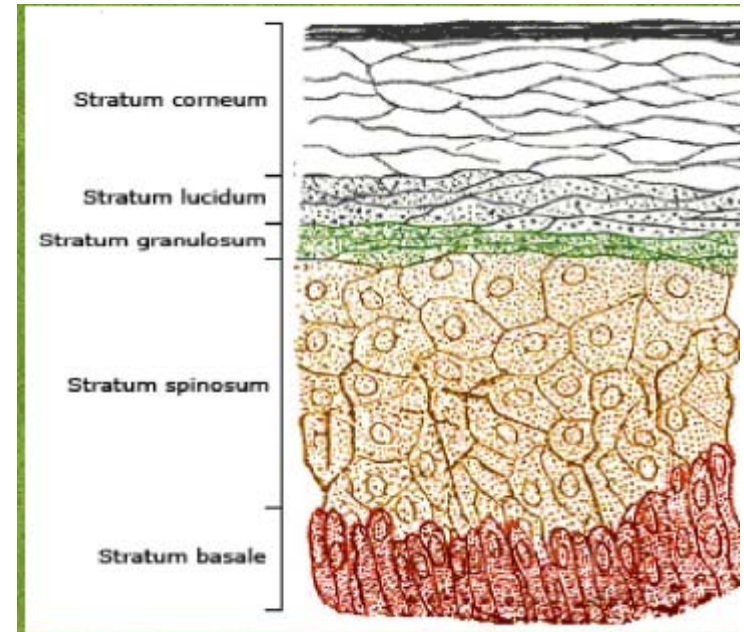
Epidermis cont.

- Generally the epidermis of vertebrates consists of five layers
- However, only tetrapods (bony fishes, mammals, birds etc.) have a stratum corneum (dead, horny, keratinised squamous cells).
- In fish keratin is replaced with mucous (glycoprotein = mucin)



Epidermis cont.

- The Stratum lucidum is a thin clear layer of dead cells
- The stratum granulosum is a thin layer (1-3 thick) of squamous cells , often with lipids, which make this layer waterproof.
- The stratum spinosum is a multilayered arrangement of cuboidal cells that sit below the stratum granulosum
- The stratum germinativum (Stratum Basale) is the basal layer above the dermis. It consists of a single layer of column like epithelial cells. These cells undergo rapid division and it is also know as the generating layer for the epidermis.



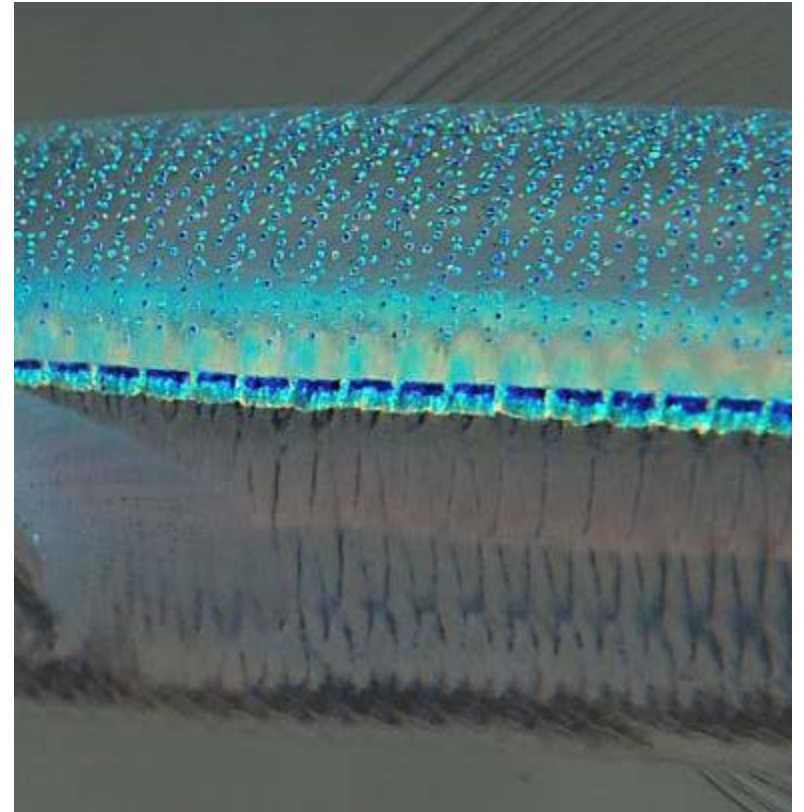
Epidermis functions

- Slime that is produced is largely protective
- Binds irritants, suspensoids and heavy metals
- Bacteria are kept at bay
- Retards chloride diffusion through skin
- Special functions – nest building
- (Anabantidae, Hepsetidae)
- lungfishes make cocoons
- In clingfishes the epidermis is has extracellular spongy cuticle to assist in adhesion on rough substrates
- The epidermis is simple and only 10-30 layers thick, for e.g., Syngnathids – only few layers over armour



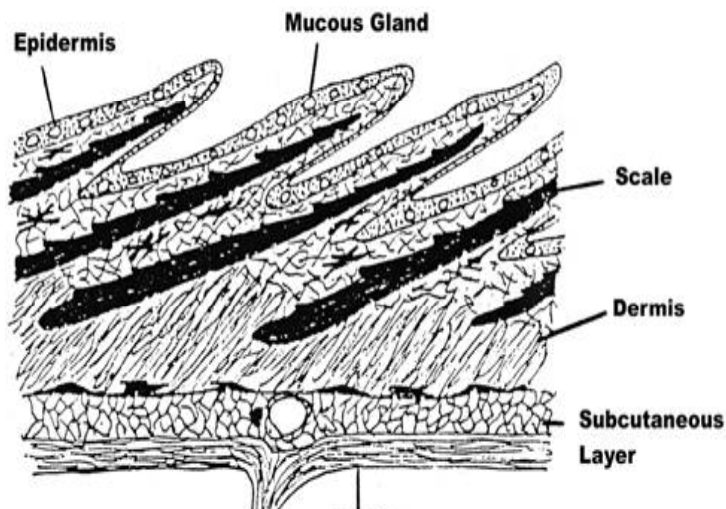
Dermis

- Mesodermal (forms in the embryo) in origin
- Thicker than epidermis
- Blood vessels, nerves, sense organs, connective tissue and pigment cells (chromatophores):
- Melanophores – Black
- Erythrophores – Red
- Xanthaphores – Yellow
- Cyanophores – blue
- Leucophores – light scattering
- Iridiophores – light reflecting - silver



Dermis

- Composed largely of a crossed-helical array of collagen fibres, Fibroblasts and collagen
- Consists of an Upper looser layer - **Stratum spongioso**
Scales are imbedded with their bases in this layer
- Lower tighter layer - **Stratum compactum**
Contains lipid cells and connective tissue
- Fish dermis - connects directly onto myosepta of the muscles and to the caudal fin.



Myosepta

- The myosepta (collagen sheets that separate layers of muscle fibres along the fish body) attach directly to the skin as well as to the backbone.
- But what is the skins function in swimming?

Function in swimming

- Fish swim by passing waves of bending posteriorly along their bodies, and these waves impart forward thrust by accelerating water through the shedding of vortices at the trailing edge of the fish's tail fin.
- This process is powered by muscles that are distributed along the full length of the fish body.
- Muscles near the head of the fish contract first and contraction proceeds posteriorly down the length of the fish to the caudal fin.
- Although researchers now have an idea of how muscle activation might be proceeding down the body, it is still unclear how the muscle force is transmitted to the tail.
- If contraction occurs at a distance from bending, muscle force must be transmitted down the body by other structures rather than by direct connection of the muscles to the vertebrae. Several structures have been suggested to transmit muscle force including tendons, myosepta, and skin.



Function in swimming

- The skin of fishes may play a substantial role in swimming mechanics.
- Fish dermis is composed largely of a crossed-helical array of collagen fibres which connect directly to the myosepta of the muscles and to the tail fin.
- The myosepta (collagen sheets that separate layers of muscle fibres along the fish body) attach directly to the skin as well as to the backbone.
- Thus, the skin forms a key component of the muscle-tendon-tail fin system in fish. The arrangement and mechanical properties of these collagen fibres may enable the skin to function in a number of ways that could decrease the cost of swimming. |
- It is likely that the skin provides a tensile container for a hydrostatic structure that contributes to the overall skeletal support of these animals, and through this type of support system it may constitute an elastic structure that would provide energy conserving mechanisms that reduce the cost of swimming.

Function in swimming

A mechanical role?

- Previous researchers have provided indications of the potential of the skin to play a major mechanical role in fish swimming, but they are far from providing clear evidence of the true role. Three major possibilities for the function of the helically-wound fibre lattice in the skin, which may not be mutually exclusive are:
 - (1) **fibre-wound hose** - the skin may provide a flexible container that allows easy bending of the animal's body without buckling, much like the action of helical reinforcing in many hoses.
 - (2) **rope** - the skin may act as a rigid linkage system that serves to transfer muscular forces generated in the anterior portion of the fish, backwards to the tail where the majority of the propulsive thrust is generated.
 - (3) **spring** - the skin may act as an elastic system that captures energy from the stretch applied to it at one stage of the locomotor cycle and then pays back this energy through elastic recoil at a later stage, in a process that might improve efficiency or enhance performance.