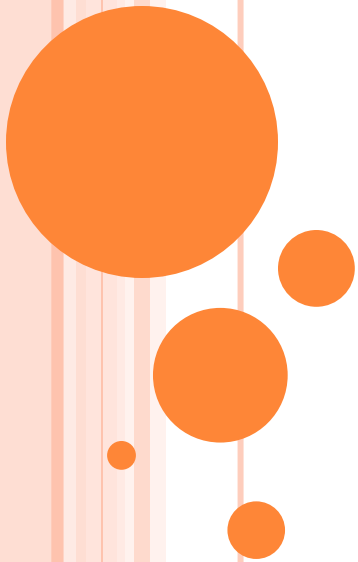


COURSE: ANIMAL FORM AND FUNCTION

Chapter: 1

PROTECTION, SUPPORT, AND MOVEMENT



- In animals, structure and function have evolved together. Several results of this evolution are protection, support, and movement.
- The **integumentary, skeletal, and muscular systems** are primarily responsible for these functions.

❖ PROTECTION: INTEGUMENTARY SYSTEMS:

The integument (L. integumentum, cover) is the external covering of an animal. It protects the animal from mechanical and chemical injury and invasion by microorganisms.

Functions of the integument:

- Regulation of body temperature
- Excretion of waste materials
- Conversion of sunlight into vitamin
- Reception of environmental stimuli, such as pain, temperature, and pressure.
- Locomotion
- Movement of nutrients and gases.



THE INTEGUMENTARY **SYSTEM OF INVERTEBRATES**

➤ **Plasma membrane**

Some single-celled protozoa have only a **plasma membrane** for an external covering.

- the plasma membrane has a large surface area relative to body volume
- gas exchange and the removal of soluble wastes occur by simple diffusion.
- facilitates the uptake of dissolved nutrients from surrounding fluids.

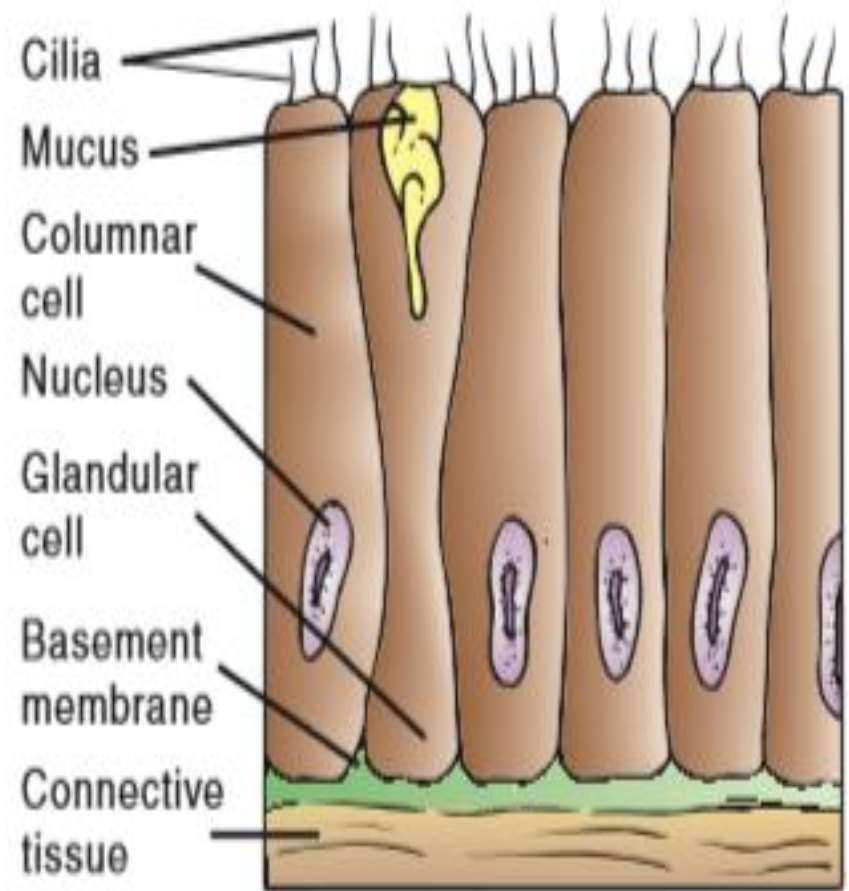
➤ **Pellicle (L. pellicula, thin skin)**

Other protozoa, such as Paramecium, have a thick protein coat called a pellicle outside the plasma membrane.

- This pellicle offers further environmental protection and is a semirigid structure that transmits the force of cilia or flagella to the entire body of the protozoan as it moves.

➤ Epidermis

- Most multicellular invertebrates have an integument consisting of a single layer of columnar epithelial cells.
- epidermis rests on a basement membrane. Beneath the basement membrane is a thin layer of connective tissue fibers and cells.
- Epidermal cells may possess **cilia**.
- The epidermis of some invertebrates also contains **glandular cells**, which secrete an overlying, non cellular material that encases part or most of the animal.



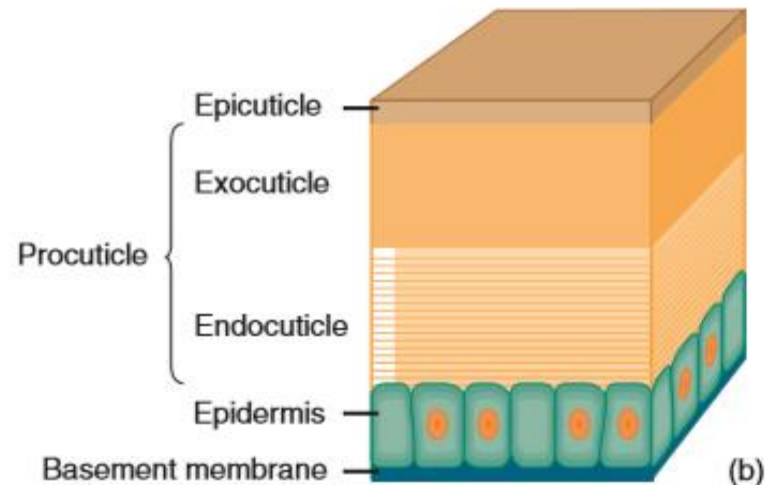
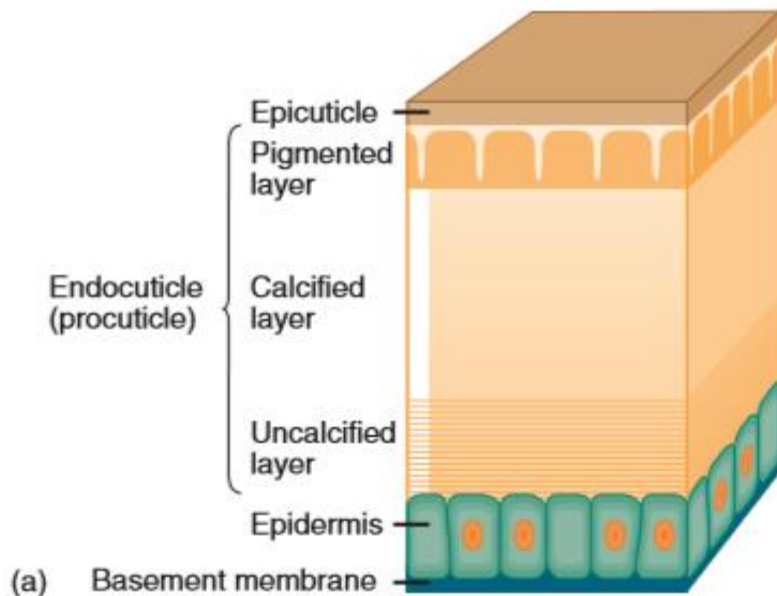
(Integument of Invertebrates)

➤ Cuticles (L. cuticula, cutis, skin)

- highly variable in structure.
- cuticles are thin and elastic cuticles in (rotifers)
- cuticles are thick and rigid and support the body in (crustaceans, arachnids, insects). Such cuticles consist of chitin and proteins in rigid plates that a flexible membrane links together.

○ Disadvantage

Animals have difficulty growing within them. As a result, some of these invertebrates (e.g., arthropods) periodically shed the old, outgrown cuticle in a process called molting or ecdysis.



➤ **tegument (L. tegumentum, tegere, to cover)**

- Nutrient ingestion and protection against digestion by host enzymes.
- The integument of echinoderms consists of a thin, usually ciliated epidermis and an underlying connective-tissue dermis containing CaCO_3 .
- Arthropods have the most complex of invertebrate integuments, in part because their integument is a specialized exoskeleton.

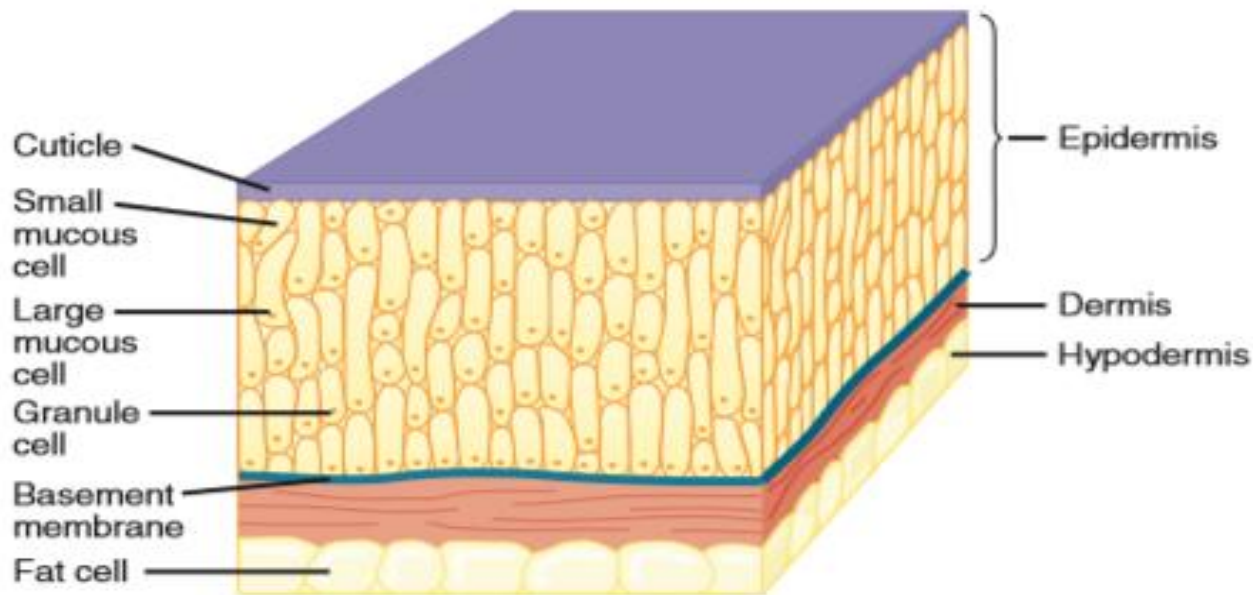
THE INTEGUMENTARY SYSTEM OF VERTEBRATES

Skin is the vertebrate integument. It is the largest organ (with respect to surface area) of the vertebrate body and grows with the animal

- 1) The Skin of Jawless Fishes
- 2) The Skin of Cartilaginous Fishes
- 3) The Skin of Bony Fishes
- 4) The Skin of Amphibians
- 5) The Skin of Reptiles
- 6) The Skin of Birds
- 7) The Skin of Mammals

1) The Skin of Jawless Fishes:

- lampreys and hagfishes
- relatively thick skin
- epidermal glandular cells that may be present, secrete a protective cuticle.
- In hagfishes, multicellular slime glands produce large amounts of mucous slime that covers the body surface.
- slime protects the animals from external parasites and has earned hagfishes the descriptive name “slime eels.”



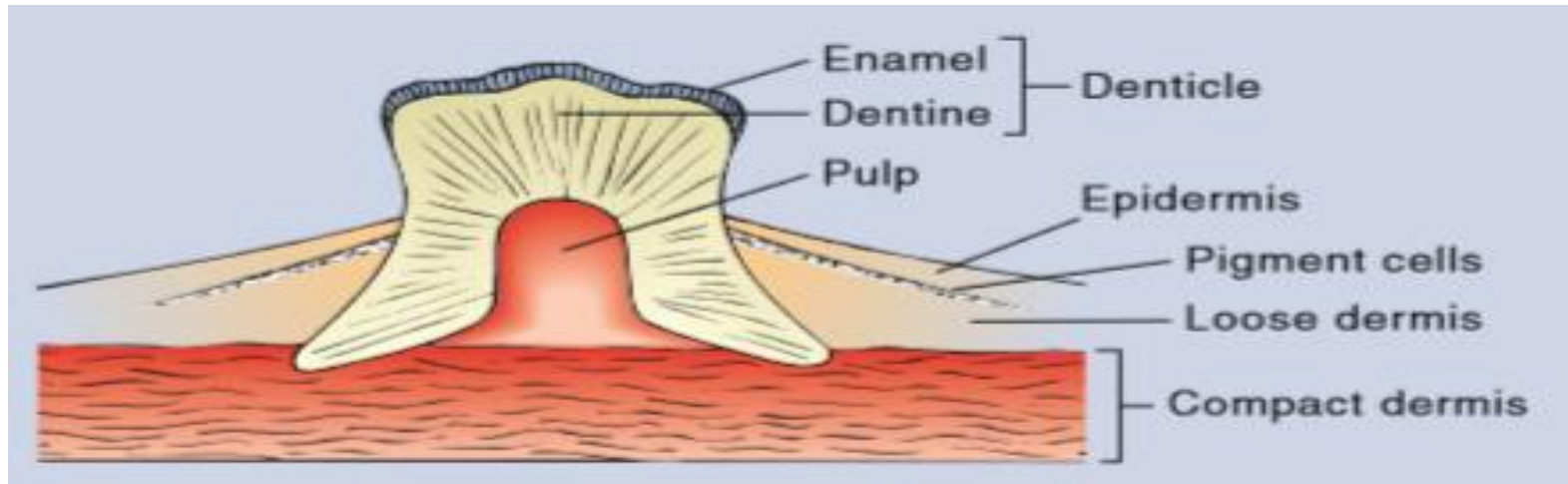
(Skin of Jawless Fishes)

2) The Skin of Cartilaginous Fishes:

- Multilayered
- contains mucous and sensory cells
- The dermis contains bone in the form of small **placoid scales** called **denticles**.

Denticles:

- Denticles contain blood vessels and nerves and are similar to vertebrate teeth.
- New denticles maintain enough of these protective structures at the skin surface.
- once denticles reach maturity, they do not grow.
- continually wear down
- they give cartilaginous fishes a sandpaper texture.



(Skin of Cartilaginous Fishes)

3) The Skin of Bony Fishes:

- The skin of bony fishes (teleosts) contains scales composed of dermal bone.
- A thin layer of dermal tissue overlaid by the superficial epidermis
- growth lines useful in determining the age of a fish.
- The skin is permeable and functions in gas exchange.
- Dermis is richly supplied with capillary beds to facilitate its use in respiration
- The epidermis contains many mucous glands to prevent bacterial and fungal infections, and reduces friction.
- Granular glands that secrete an irritating or poisonous alkaloid.
- Many teleosts that live in deep aquatic habitats have photophores.

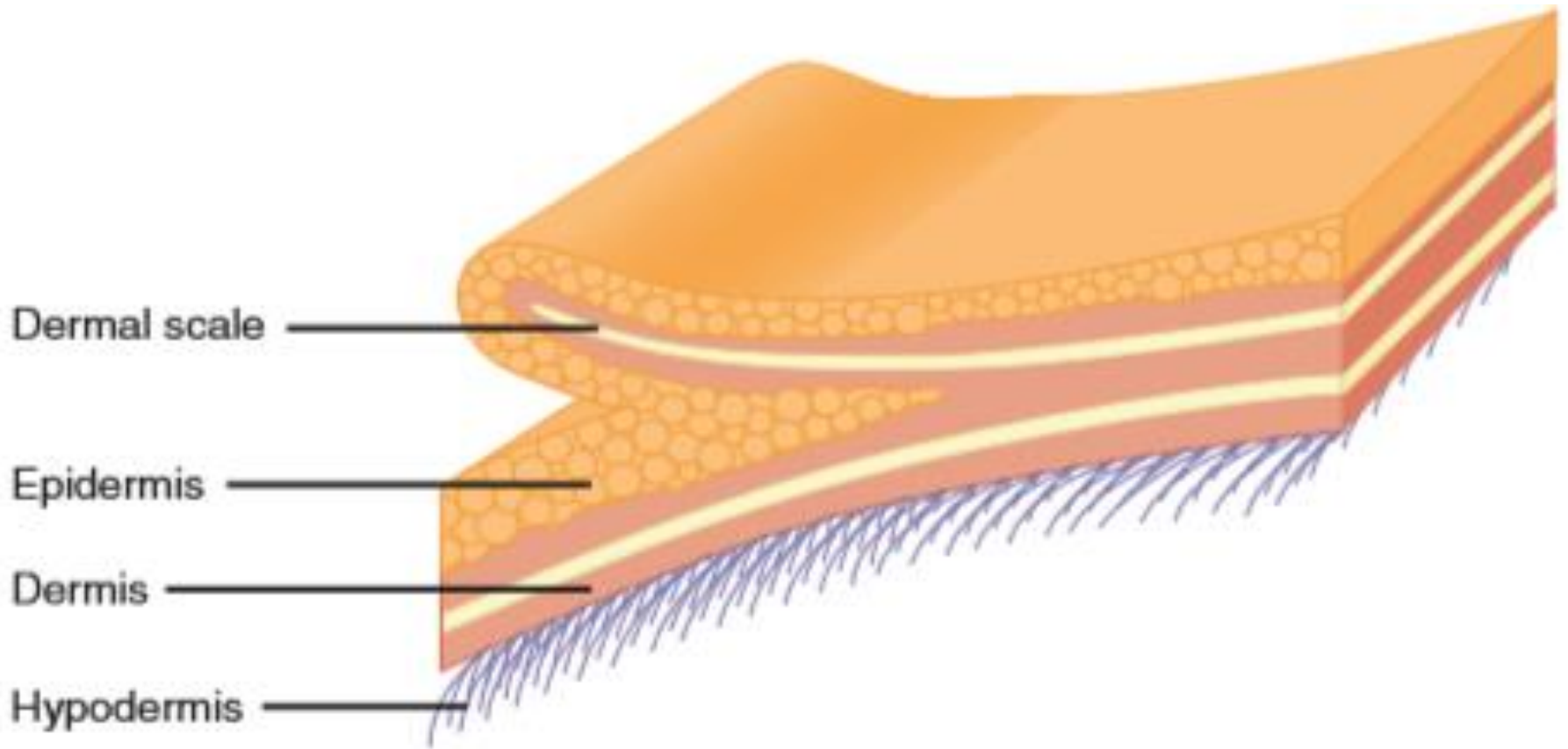
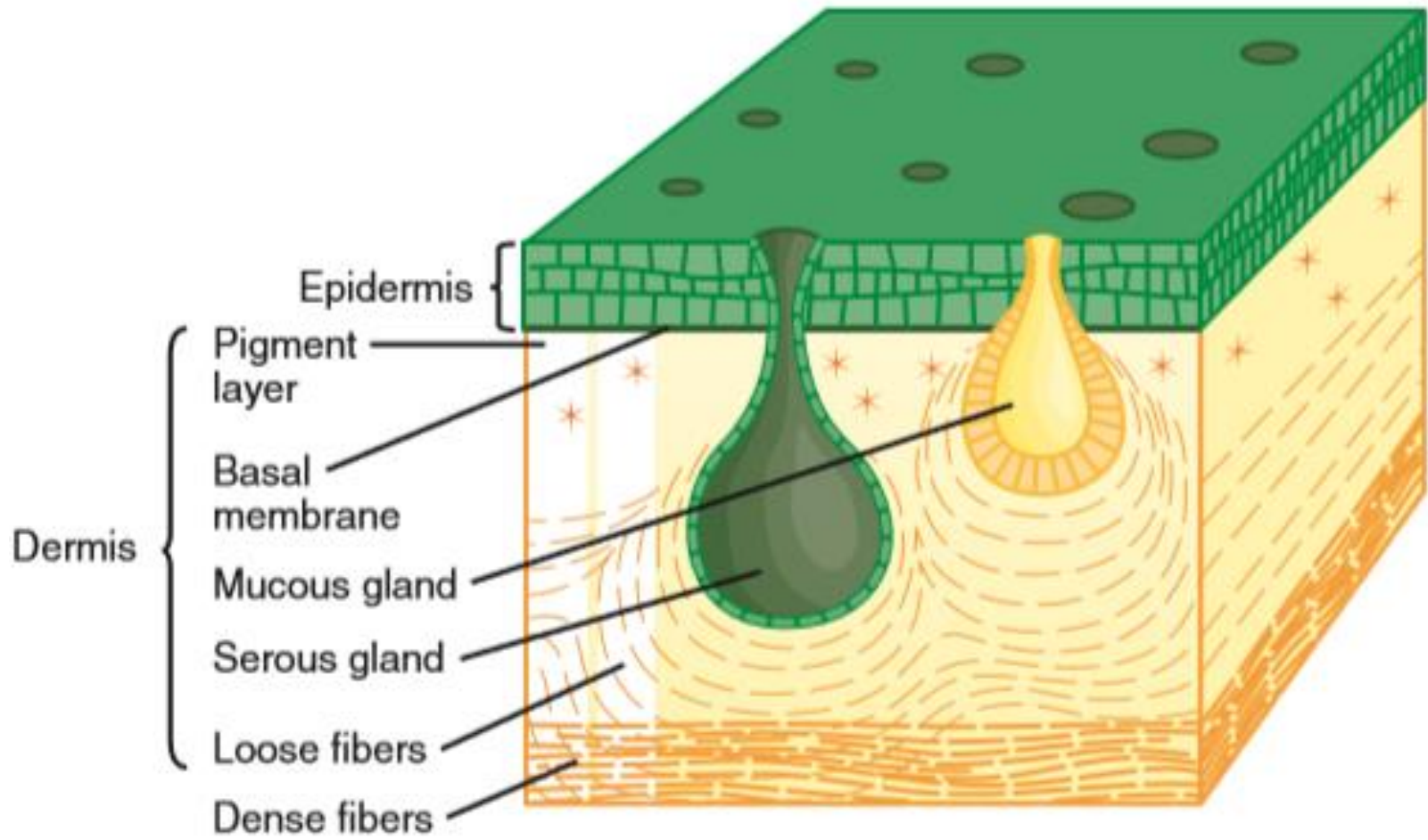


Figure: Skin of Bony Fish

The skin of a typical bony fish has overlapping scales (two are shown here). The scales are layers of collagenous fibers covered by a thin, flexible layer of bone.

4) The Skin of Amphibians

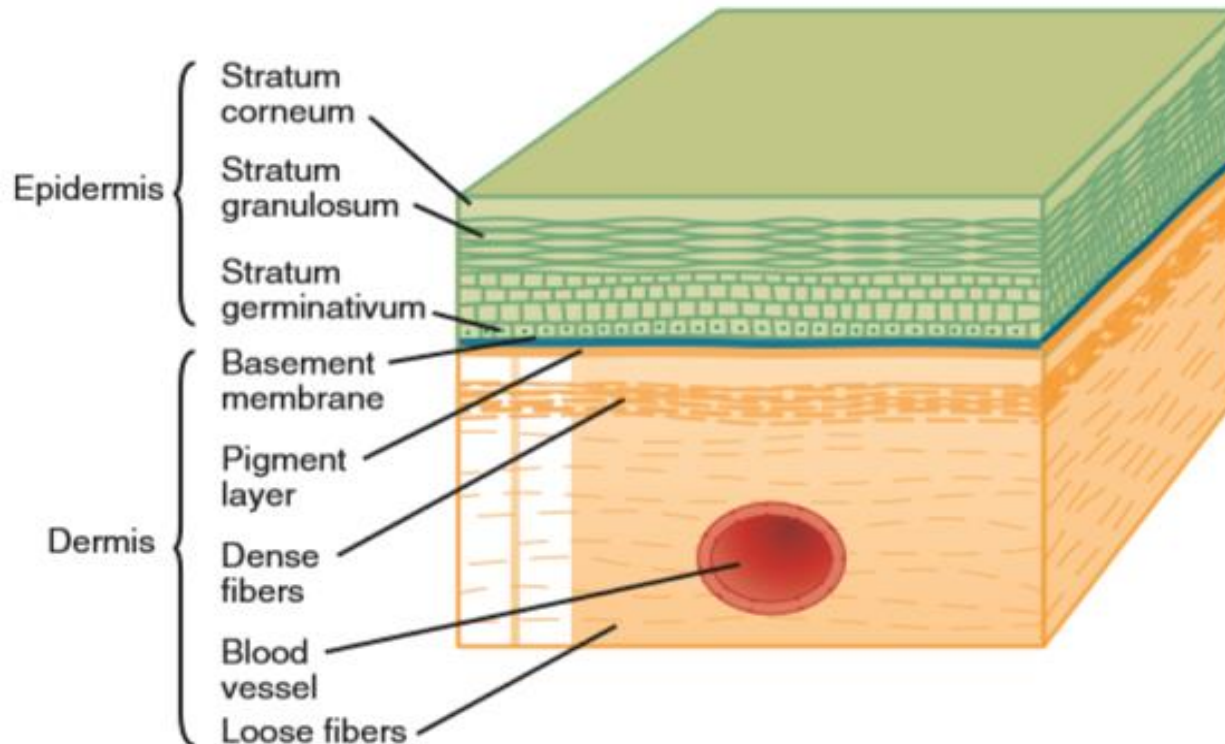
- Stratified epidermis
- Dermis containing mucous and serous glands plus pigmentation cells.
- Phylogenetically, amphibians are transitional between aquatic and terrestrial vertebrates. The earliest amphibians were covered by dermal bone scales like their fish ancestors.
- During evolution keratin production increased in the outer layer of skin cells to protect the cells, especially their nuclear material, from ultraviolet light.
- The mucus that mucous glands produce helps:
 - prevent desiccation
 - facilitates gas exchange
 - makes the body slimy, which facilitates escape from predators.



(Skin of Amphibians)

5) The Skin of Reptiles:

- Reflects their greater commitment to a terrestrial existence.
- epidermis (stratum corneum) is thick lacks glands, and modified into keratinized scales, scutes, beaks, claws, plaques, and spiny crests
- keratinized layer resists abrasion, inhibits dehydration, and protects
- During molting the old outer layer separates from newly formed epidermis. Diffusion of fluid between the layers aids this separation.



Skin of Reptiles

6) The Skin of Birds:

- Skin shows many typically reptilian features
- Epidermal gland is the **uropygial** or **preen gland**.
- Epidermis is usually thin and only two or three cell layers thick. The outer keratinized layer is often quite soft.
- Feathers derived from scales of reptilian ancestors.
- Dermis contains blood and lymphatic vessels, nerves, and epidermally derived sensory bodies.
- Associated with the feathers is complicated array of dermal smooth-muscle fibers that control the position of the feathers.
- Aquatic birds may also have fat deposits in the hypodermal layer that store energy and help insulate the body.

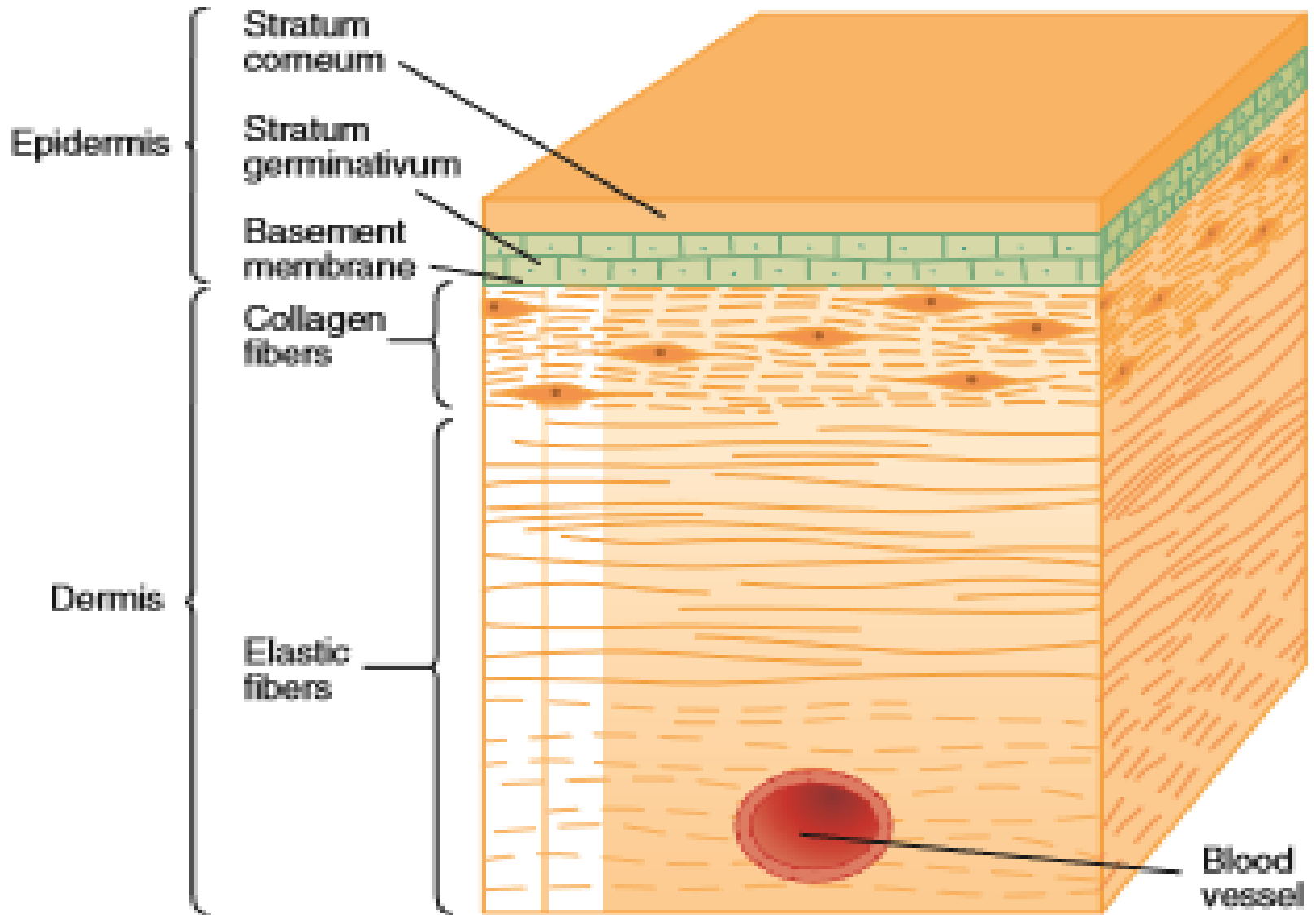


Fig: Skin of Birds. Bird skin has a relatively soft and thin epidermis with no epidermal glands.

7) The Skin of Mammals:

The notable features of mammalian skin are:

- 1) Hair
- 2) a greater variety of epidermal glands
- 3) a highly stratified, cornified epidermis
- 4) The epidermis is composed of stratified squamous epithelium and consists of several layers of a variety of cells.

- Keratinized cells make up the outer skin layer, called the stratum corneum.
- Thick dermis contains blood vessels, lymphatic vessels, nerve endings, hair follicles, small muscles, and glands.
- hypodermis consists of loose connective tissue, adipose tissue, and skeletal muscles.

Functions of skin:

- ✓ regulates body temperature
- ✓ Screens out excessive harmful ultraviolet rays from the sun
- ✓ containing sensory receptors for heat, cold, touch, pressure, and pain.

Glands

1. **Sudoriferous glands** secrete sweat by a process called **perspiration**.
2. **Sebaceous (oil) glands** connected to hair follicles in the dermis They lubricate and protect by secreting sebum.
 - Sebum is a permeability barrier, an emollient (skin-softening agent), and a protective agent against microorganisms. Sebum can also act as a pheromone.

Pigments

Pigments are within the cells of the epidermal layer, in hair, or in specialized cells called chromatophores.

Hair

An arrector pili muscle (smooth muscle; involuntary muscle) attaches to the connective-tissue sheath of a hair follicle surrounding the bulb of the hair root

Nails

- Nails are flat, horny plates on the dorsal surface of the distal segments of the digits (e.g., fingers and toes of primates)
- Other keratinized derivatives of mammalian skin are horns (not to be confused with bony antlers) and the baleen plates of the toothless whales

