

INTEGUMENTARY SYSTEM

The skin & associated structures make up the integumentary system. The skin protects land dwelling organisms from desiccation & from loss of heat. Skin is a mammal's largest organ. It protects the body against physical, chemical & biological attacks, it helps to regulate body temperature, it is used to communicate to other individuals, & a skin derivative provides nourishment for the young.

Like the integument of other vertebrates, mammalian skin is composed of 2 layers, the dermis & the epidermis.

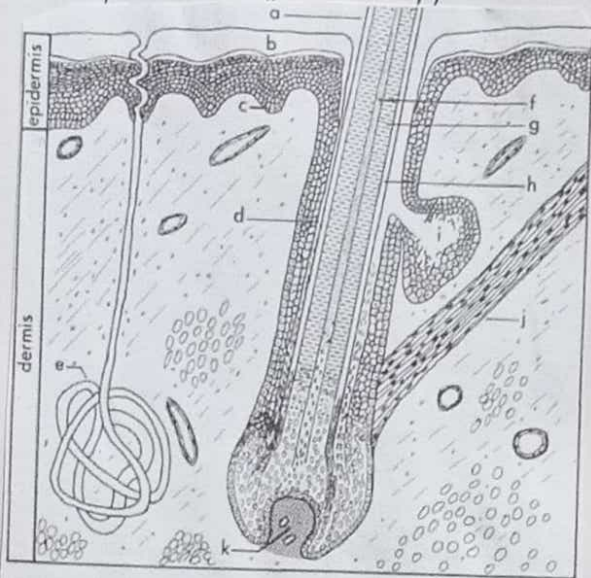


Figure 4-1. Sectional view of skin showing hair and various structures in dermis and epidermis. a, hair; b, stratum corneum; c, stratum germinativum; d, hair follicle; e, eccrine sweat gland; f, medulla; g, cortex; h, cuticle; i, sebaceous gland; j, arrector pili muscle; k, papilla.

Epidermis - the epidermis consists of several layers, representing successive stages of development. The oldest part of the skin is the outer layer of tough, protective, cells. The cells which are dead are continually worn off at the surface & replaced from below. As the cells age & mature, they eventually lose their nuclei & most of the cell contents are converted to keratin.

The outermost layer of epidermis is the stratum corneum. The epidermis on the soles of feet & the palms of hands is thick. Thickened portions of the epidermis form the pads on the feet of most mammals & the friction ridges on the digits & palm of primates. Hair, Horn, claws & epidermal scales are all made of modified keratinized cells of epidermal origin.



Dermis - The dermis lies below the epidermis. It is a thick layer of connective tissue with associated muscles, nerves & blood vessels. The connective tissue consists largely of collagen. Collagen may be up to 6% of body weight in humans. It is the most abundant protein in the body, being present in skin, bones, cartilage & ligaments. Collagen is from a Greek word meaning "glue-marker". Beneath the dermis is a layer of fatty tissue, variably thick that provides insulation & energy storage. In many species, the extent of subcutaneous fat varies dramatically with season.

Subcutaneous fat in a deer in the winter. This picture is of the subcutaneous fat of a yearling doe (nearly 2 years old) that was hit by a car 2/8/04. On the left ^{is in} image from just anterior to the tail cut through the tissue, & on the right is much of the back with the skin peeled back.



Skin glands: Associated with the skin are 2 kinds of glands, sweat glands & sebaceous glands. The epidermal sebaceous glands lubricate the hair. Sweat glands (sudoriferous glands) are coiled tubes in the dermis connected with the surface by narrow ducts. Some

mammals such as rodents & lagomorphs (rabbits) do not have sweat glands. cats (Felidae) & dogs (Canidae) & perhaps other carnivores, have sweat glands in the pads of the feet.

Hair :

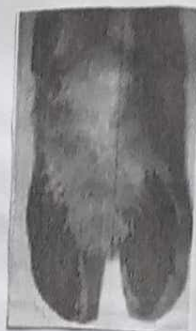
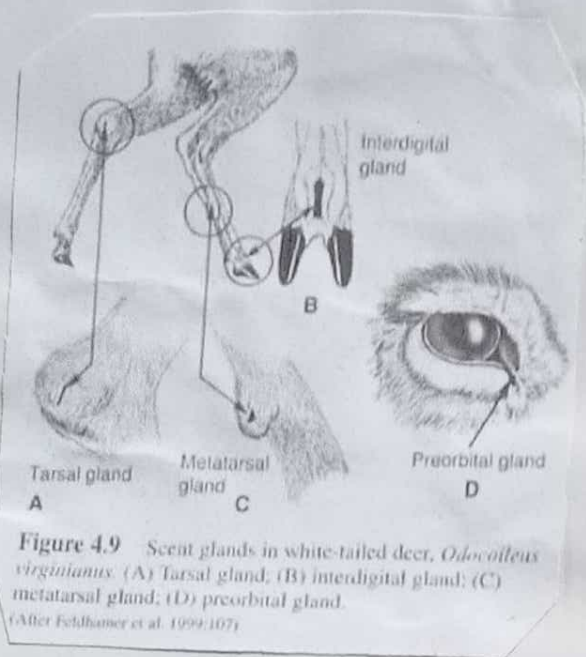
General - Hair is a uniquely mammalian feature. The developing epidermis invaginates into the dermis to form a follicle. At the deepest point of the follicle, the dermis pushes back & forms a small structure called the papilla.

Each hair consists of three parts. The center is the medulla (Latin, "marrow"). This is surrounded by a denser cortex (Latin, "bark") containing most of the pigment granules that give each hair its characteristic color. The cortex is covered by a thin layer called the cuticle (Latin, "little skin").

Glands - Sebaceous glands open into each follicle. They secrete oily substances (sebum) that continually lubricate & condition skin & hair. Glands that secrete cellular debris as well as molecular products are termed apocrine glands. These glands empty into or near a hair follicle.

There are many examples of skin glands that have moved beyond their roles in lubrication to serve other functions. We have a skunk study skin in the laboratory but do not have the anal sac from which the skunk sprays. Many species use glandular scents to mark individual territories, particularly the carnivores (order Carnivora).

Fig. Scent glands in the white-tailed deer (Odocoileus virginianus). Legs from a deer may be available in class to find these glands.



Hair musculature - Hair doesn't grow vertically from the skin but emerges at an angle, which can be altered to regulate the depth of the pelage. A small arrector pili muscle is attached to each follicle. Hair "standing on end" increases the insulative value by increasing the dead air space.

Kinds of Hair - Hair with continuous growth (human head hair or a horse's mane) is called angora hair. Definitive hair ceases to grow at a certain point & is replaced periodically when the animal molts.

The pelage (or coat) that we usually see is the body hair or guard hair. Guard hairs are frequently long, stiff hairs; they serve mostly for protection. Bristles show angora growth. In certain mammals hair are so stout & strong that they form spines. The 3rd type, which is most common, is awns. Awns are guard hairs with definitive growth & are the most noticeable hairs on most mammals.

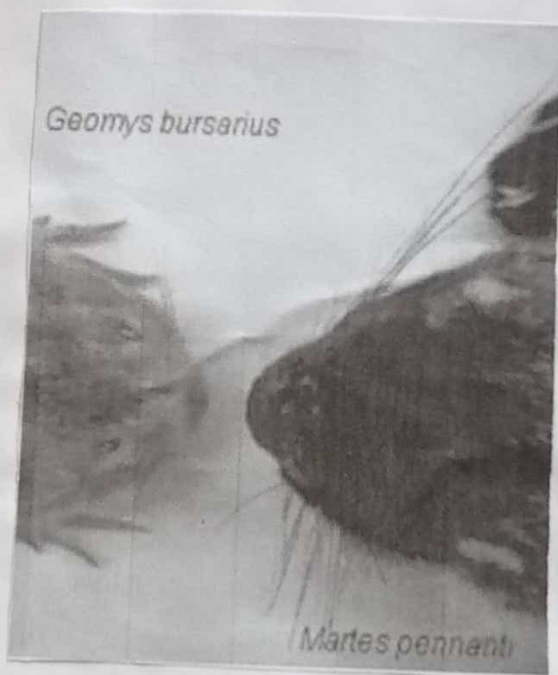
Examine skins of a variety of mammals - such as the porcupine, hare (*Lepus americanus*), ermine (*Mustela erminea*), otter (*Lutra canadensis*) & moose (*Alces alces*).

Underhairs are shorter & finer hairs growing around the guard hairs often in much greater numbers. Their function is to insulate. Underhairs with angona growth are called wool.

The pelage of an animal is the combination of longer guard hairs & the underfur (underhairs), fine & relatively short hair with definitive growth that densely covers most mammals.

Special tactile hairs, the vibrissae, are found not only a mammal's face (mystacial vibrissae) but many occur also on the legs or elsewhere on the body. Vibrissae are especially prominent on the muzzles of nocturnal & burrowing mammals. Humans do not have vibrissae.

Fig: Vibrissae on the porcupine & pocket gopher (Geomys bursarius) & the fisher.



Color - Mammalian hair & skin coloration serves 3 basic functions: (1) protection from electromagnetic radiation (especially ultraviolet light), (2) concealment (crypsis) by camouflage, countershading, or disruption & (3) communication, such as the "warning" color patterns in skunks (Mephitis mephitis).

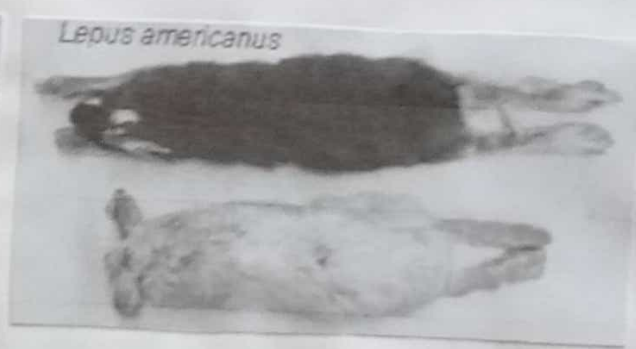
Bright colors are rarely depends on the kind &

concentration of pigment granules, in the cortex. The different pigments are not evenly distributed over the length of each hair. Most hairs show a pattern called agouti: they have a black tip followed by successive bands of different pigments.

Hair Replacement -

The pelage must be maintained to maintain its functionality. Hair cannot be repaired when damaged because, it is non living. Most hair is of definitive growth & is replaced periodically. The process is called molting. 2 kinds of molts are recognized: maturational molt & seasonal molt, which usually occurs once or twice a year & often follows a regular spatial pattern within a particular species.

Fig: Compare winter & summer pelts of ermine (Mustela erminea) & the snowshoe hare (Lepus americanus) that are present in the lab.



Members of the deer family are a good example of this, moose calves are reddish in color, for example. There is the skin of a white-tailed deer fawn in the laboratory, compare its hair to that of the adult deer.

Scales - The scales on the more or less naked tails of rats, mice & beavers are protective, epidermal thickenings of the skin made of keratinized cells. The pangolin (order pholidota) is covered with epidermal scales of a different kind.

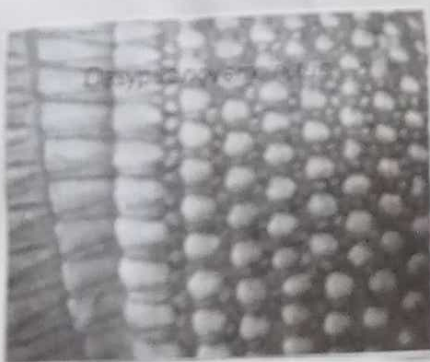
They consist of keratinized cells & are in structure & development basically equivalent to hairs.

Fig: Examine the scaly tail of a beaver (*Castor canadensis*) on rat (*Rattus norvegicus*) on opossum (*Didelphis virginiana*).



The armadillo (Edentata: Dasypodidae) has both epidermal scales & dermal bone. The epidermal scales resemble the scales on the tails of the rats, & beavers. The dermal bone is unique among mammals. It is true bone within the dermis, forming a shell constructed somewhat like the armor of a medieval knight. Today dermal bones are found in some modern fish, in the shells of turtles & in the skin of many lizards & crocodilians.

Fig: Shell of 9-banded armadillo (*Dasypus novemcinctus*).

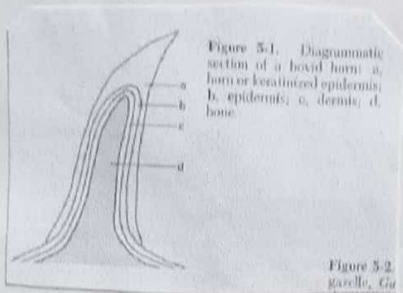


Horns & Antlers:

Horns & antlers are found today only in 2 mammalian orders: Artiodactyla & Perissodactyla. Extinct mammals from other orders (including the Rodentia) also had cranial ornamentations. These kinds can be distinguished by their location on the head & their mode of development. You should be able to distinguish true horns, pronghorns & antlers.

Horns: - True horns are found only in the family Bovidae (order Artiodactyla). True horns are always unbranched & permanent & are composed of 2 parts: the bony horn core & the horn itself. Horns are covered by a sheathing layer of keratinized epidermis, the horn.

Fig: Diagram of horn (DeBlase & Martin 1981) on the left & the horn core & horn of a bison on the right.



Examine horns & horn cores of the available bovids (cow, Bos taurus, & on wall bighorn (sheep, Ovis canadensis & mountain goat, Oreamnos americana). There are no cross-sections of horns in the UMD collection.

Pronghorns - The pronghorn (Antilocapra americana) of western North America is the only living species of the family Antilocapridae (Artiodactyla). As the Bovidae the horn (properly called pronghorn) has a bony core covered by a keratinized sheath & serves a similar function. However, unlike other horns, in pronghorns the sheaths

are (1) branched & (2) deciduous.

Fig: 57 Cross-sectional diagram a pronghorn (GeBlase & Martin, 1981).

Antlers - Antlers are only found in the family Cervidae (Artiodactyla). Antlers are present only in males, except for female caribou (reindeer) in the genus Rangifer. Fully developed antlers are made completely of bone. They arise from bony stumps (pedicels) on the frontal bones. The pedicels are covered with skin. The developing antlers are covered with a layer of skin & short hairs. This "velvet" carries blood vessels & nerves supplying the growing bone. Antlered animals tend to use their hooves for defense ~~between~~ when attacked by predators.

Fig: 53 Diagrammatic cross-section of a developing antler (GeBlase & Martin 1981).

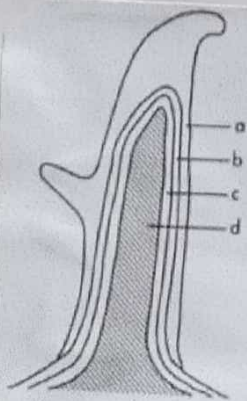


Figure 5-3. Diagrammatic section of a pronghorn: a, keratinized epidermis; b, epidermis; c, dermis; d, bone.

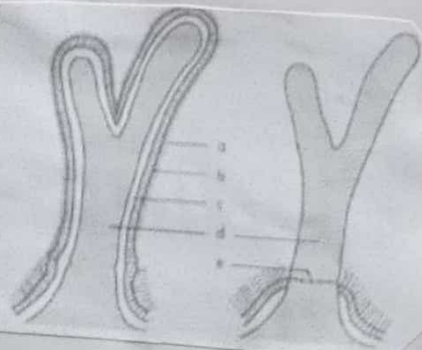
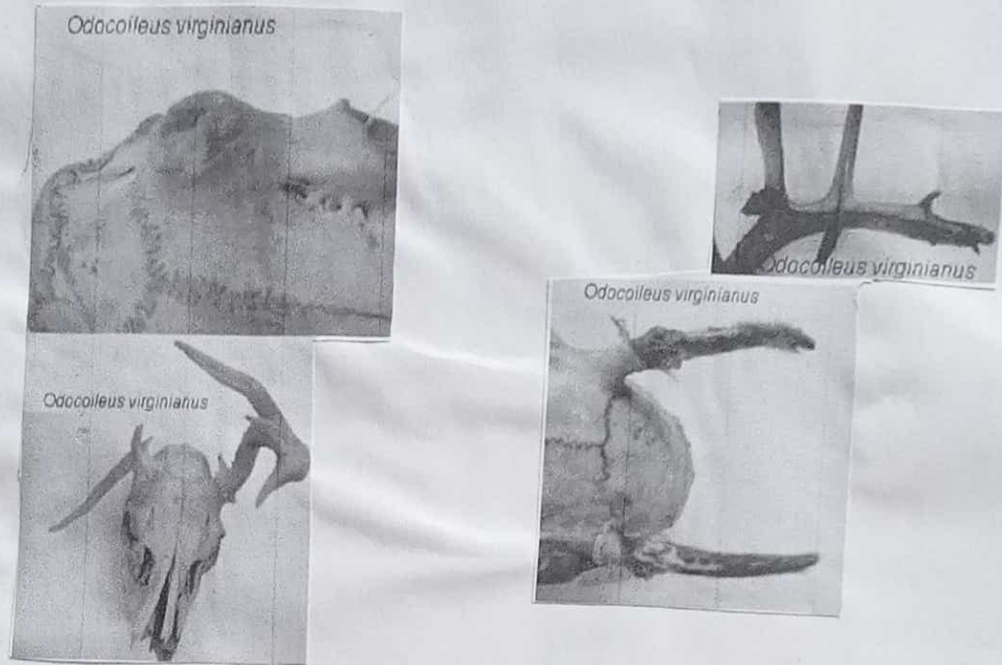


Figure 5-4. Diagrammatic section of antler with (A) and without (B) velvet. a, velvet; b, epidermis; c, dermis; d, bone (or antler); e, abscission line at region of burr.

(10)

Fig: Sample skulls of deer (Cervidae) in the laboratory showing different aspects of antler growth.



Be able to distinguish to species the antlers of available cervids (mule deer Odocoileus hemionus & white-tailed deer Odocoileus virginianus, wapiti (elk) Cervus elphus, moose, Alces alces & caribou Rangifer tarandus. Wapiti antlers are larger than deer antlers & have a single beam that branches. White-tailed deer antlers typically curve forward & around, while mule deer antlers appear to branch rather than curve around. The mule deer antlers present in the laboratory are not the best example of this type of branching (as opposed to curving around).

Fig: Drawing of different antler shapes & body size of extant members of the deer family in North & South America (from Geist 1999). Note the curvature on the white-tailed deer antler compared to the branching on the mule deer antler.



Fig. 6-1. The living New World deer, shown in size and arranged by size from front to rear, are very diverse in appearance. (A) The South American Pudu puda is the smallest of all living deer; (B) the brocket deer Mazama; (C) the Andean mountain deer or huacachaeco; (D) the panther deer Otocorys; (E) the swamp-adapted marsh deer Blainvillia; (F) the white-tailed deer Odocoileus virginianus, tropical form; (G) the white-tailed deer large northern form; (H) the mule deer Odocoileus hemionus; (I) the reindeer Rangifer tarandus; (J) the moose Alces alces. The pudu and the brocket deer are ecologically "nicheless" in their habitats; the huacachaeco is a goatlike mountain deer; the panther deer is a gregarious form inhabiting forest grasslands; the marsh deer is a swamp specialist similar to the African swamp deer; the white-tailed, the moose, and the reindeer are all temperate zone opportunists; the reindeer and the moose are sympatric in the tundra with a circumpolar distribution.

Look at the skulls of male & female moose & also at the skulls of male & female deer.

Claws, Hooves, Nails:

Objectives - In this section we learn about claws, hooves, & nails of mammals.

The ends of most digits of mammals other than whales & most sirenians are protected by hardened plates of the protein keratin (also present in hair). These plates take the form of claws, nails or hooves.

Claws - The claw is the ancestral form of digital covering. A claw is composed of a harder dorsal plate called the unguis & a softer ventral plate termed the subunguis. The subunguis is continued by the cushion like pad.

Dogs & cats walk on these pads. A claw is thicker in the median line than at the sides. In addition to the protection of the digits, claws are used in many ways for climbing, digging, hanging on grasping & even killing prey.

Fig:

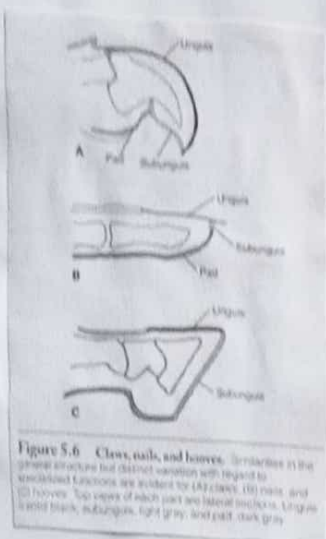


Diagram of claws & nails (Romer for the horizontal figure, Feldhamer 2004 for the vertical figure)



Fig: Pictures of claws of several species that are present in the lab.

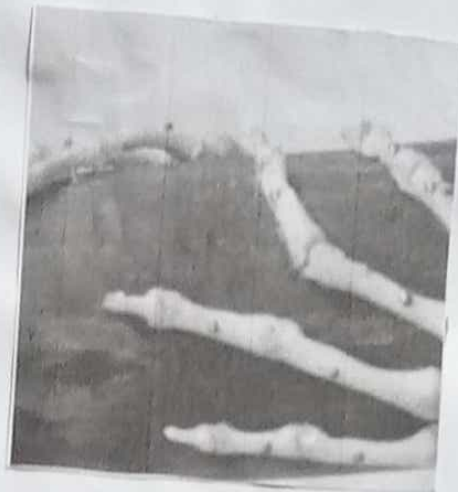
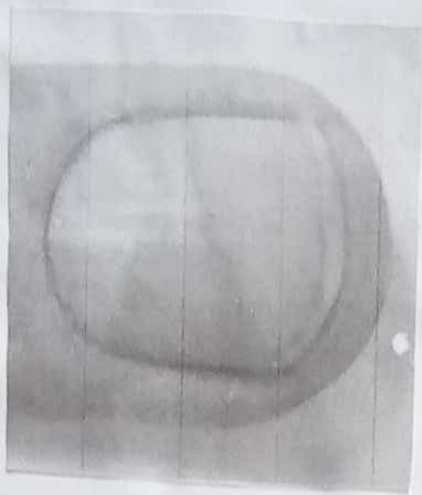


Nails: A nail is a simplified derivative of a claw covering only the dorsal surface of the digit. Compared to a claw, the nail's wide unguitractor is thinner & less rigid & the subunguis is very much reduced. A nail offers less projection than does a claw but exposes the end of the digit to permit more

precise manipulation of objects.

Example .

Fig: Fingernail of a human (Homo sapiens) & the hand skeleton of a monkey, species unknown.



Hooves - Well developed hooves are found among extant mammals only in ungulates (Artiodactyla & Perissodactyla). They are further modified claws in which the unguis encloses both the end of the digit & the subunguis. The pad lies just behind the hoof & is called the frog. In ungulates normally only the hoof, not the frog, is in contact with the ground.

Fig: Picture of Bos taurus hoof in laboratory.

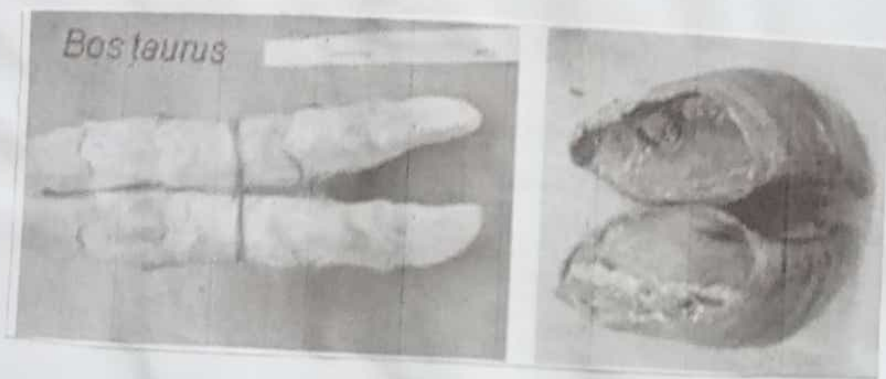
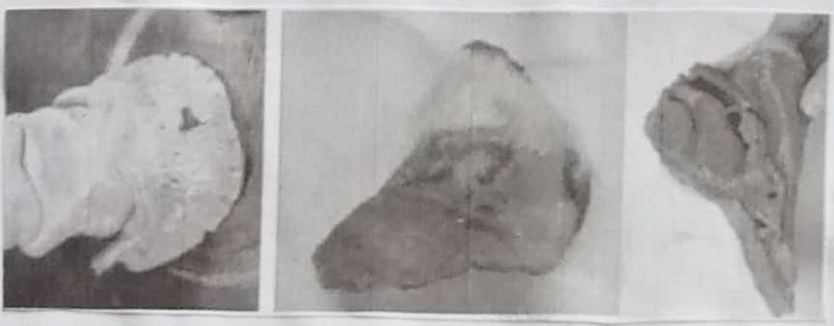


Fig: Pictures of Odocoileus virginianus hooves that are available in the laboratory.



Fig. Pictures of horse hoof (Equus caballus) in laboratory. First row, left to right is the hoof on mounted leg, side view of hoof & cross-section. Bottom row is a view of the cross-section from the bottom.



Orders	Family	Species	Common name
Artiodactyla	Cervidae	<u>Odocoileus virginianus</u>	White-tailed deer
Carnivora	Mephitidae	<u>Mephitis mephitis</u>	Striped Skunk
Rodentia	Erethizontidae	<u>Erethizon donbatum</u>	Porcupine
Rodentia	Geomysidae	<u>Geomys bursarius</u>	Pocket gopher
Rodentia	Castoridae	<u>Castor canadensis</u>	Beaver
Artiodactyla	Cervidae	<u>Cervus elaphus</u>	Elk
Artiodactyla	Cervidae	<u>Alces alces</u>	Moose
Artiodactyla	Cervidae	<u>Odocoileus virginianus</u>	White-tailed deer
Artiodactyla	Cervidae	<u>Odocoileus hemionus</u>	Mule deer
Artiodactyla	Cervidae	<u>Rangifer tarandus</u>	Caribou, Reindeer
Artiodactyla	Bovidae	<u>Bos taurus</u>	Cow
Artiodactyla	Ovidae	<u>Ovis canadensis</u>	Bighorn Sheep
Artiodactyla	Ovidae	<u>Oreamnos americana</u>	Mountain goat
Artiodactyla	Antilocapridae	<u>Antilocapra americana</u>	Pronghorn antelope
Perissodactyla	Equidae	<u>Equus caballus</u>	Horse
Rodentia	Sciuridae	<u>Sciurus carolinensis</u>	Gray Squirrel
Carnivora	Mustelidae	<u>Lutra canadensis</u>	Otter
Carnivora	Mustelidae	<u>Taxidea taxus</u>	Badger
Carnivora	Mustelidae	<u>Mustela erminea</u>	Ermine
Artiodactyla	Cervidae	<u>Alces alces</u>	Moose
Lagomorpha	Leporidae	<u>Sylvilagus floridanus</u>	Eastern Cottontail
Lagomorpha	Leporidae	<u>Lepus americanus</u>	Snowshoe hare
Rodentia	Sciuridae	<u>Marmota monax</u>	Woodchuck
Xenarthra	Dasypodidae	<u>Dasypus novemcinctus</u>	Armadillo
Rodentia	Muridae	<u>Ondatra zibethicus</u>	Muskrat