

INTEGUMENTARY SYSTEM

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

Like the integuments of other vertebrates, mammalian skin is composed of two layers, the dermis and the epidermis. Identify and locate the structures underlined in the following text in Fig.

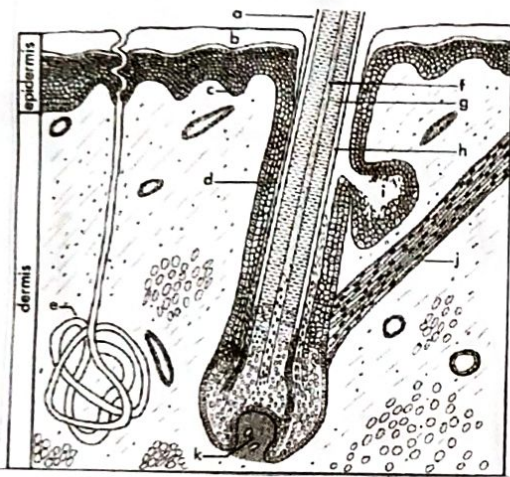
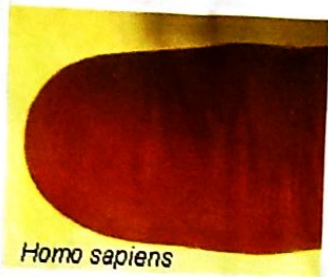


Fig:- Cross-sectional diagram of skin surface.

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 and replaced from below. As the cells age and mature, they eventually lose their nuclei

and most of the cell contents are converted to keratin, keratin is a protein that makes up protective layer of skin, and also such structures as nails, hooves, hair, and horns - evolutionary and developmental derivatives of skin.

The outer most layer of epidermal is the stratum corneum. The epidermis on the soles of feet and the palms of hands is thick; elsewhere on the body, the epidermis may be quite thin. Fingerprints are the impression of these friction ridges, calluses are also products of the epidermis. Hair, horn, claws, and epidermal scales are all made of modified keratinized cells of epidermal organ.



Homo sapiens

Pine marten
Front paw
Martes americana

Fig:- Fingerprint of human (Homo Sapiens), we may have an Opportunistic Sample (e.g. ... last year had a pine marten (Martes americana))

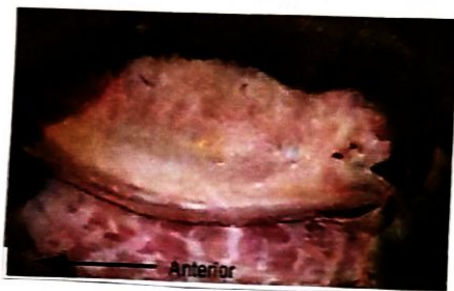
Dermis:- The dermis lies below the epidermis, it is a thick layer of connective tissue with associated muscles, nerves, and blood vessels. The connective tissue consists largely of collagen. Collagen may be up to 25% of body weight in humans, and is the most abundant protein in the body, being present in skin, bones, tendons, cartilage and ligaments; collagen is from a Greek word meaning

"glue-maker": collagen and the other fibers in the dermis become toughened and hardened during the process of tanning when a skin is transformed into leather. Unlike the epidermis, the dermis is well-supplied with blood vessels and nerves for sensation of touch, pressure, temperature, and pain.

Subcutaneous fat in a deer in the winter. This picture is of the subcutaneous fat of a yearling doe that was hit by a car on 2/8/04. On the left is an image from just anterior to the tail cut through the tissue; and on the right is much of the back with the skin peeled back.



Odocoileus virginianus Back fat



Anterior

Skin glands Associated with the skin are two kinds of glands; sweat glands and sebaceous glands. The epidermal sebaceous glands lubricate the hair and are described below. Sweat glands are coiled tubes in the dermis connected with the surface by narrow ducts. Cats and dogs and perhaps other carnivores, have sweat glands in the pads of the feet. It is thought that mammary glands evolved from sweat glands as discussed below.

Hair:-

General:-- Hair is 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

and forms a small structure called papilla. The papilla is well blood vessel. Epidermal cells on top of the papilla multiply and are pushed towards the surface by those growing beneath them, keratinizing and forming the hair.

Each hair consists of three parts. The center is the medulla. This is surrounded by a denser cortex containing most of the pigment granules that give each hair its characteristic color. They are never pigmented.

Glands:- Sebaceous glands open into each follicle. They secrete oily substances that continually lubricate and condition skin and hair, cells inside these glands gradually fill with grease and then break away, becoming the part of the secretion themselves. 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. In skunks protective and communicative functions are both present. Many species use glandular scents to mark individual territories, particularly the carnivores.

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

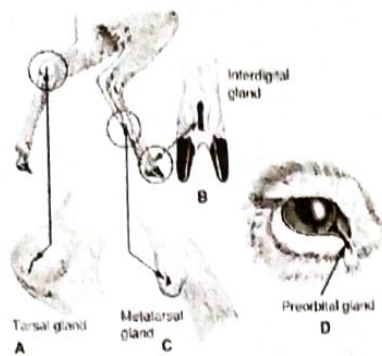


Figure 4.9 Scent glands in white-tailed deer, *Odocoileus virginianus*. (A) Tarsal gland, (B) interdigital gland, (C) metatarsal gland, (D) preorbital gland. (After Feldhamer et al. 1996: 67)



Hair musculature: Hair does not grow vertically from the skin but emerges at angle, which can be altered to regulate the depth of the pelage. A small arrector p. muscle is attached to each follicle. As that muscle contracts, it increase the thickness of the insulating layer of hair "standing on end" increases the insulative value by increasing the dead air space.

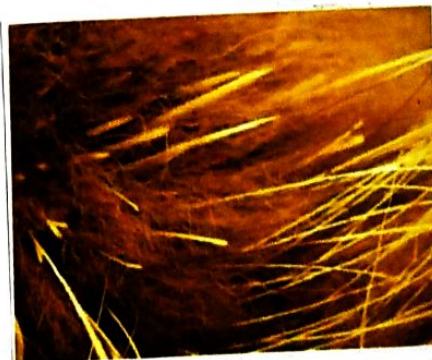
Kinds of Hair. - Hair with continuous growth is called angora hair. It continues to grow throughout the life of the animal and is not molted.

The pelage that we usually see is the body hair. on guard hair. There are three different types of guard hairs. Guard hairs are frequently long, stiff hairs, they serve mostly for protection. The North American porcupine has barbs on the tips of its spines that break off at base if touched by a predator and work into the flesh.

Fig- Tip of spine of porcupine quill.



Figure 4.6 Enlarged view of a quill tip of a New World porcupine (*Erethizon dorsatum*). Note presence of barbs. (Stadle and Chedley 1949:172)



Examine skins of a variety of mammals — such as the porcupine, hare ermine (*Mustela erminea*), otter, and moose (*Alces alces*). Identify the types of hair found on each. What is the function of each kind of hair? What differences do you see among these different animals that might be associated with the habitats they normally live in? Why might moose or deer hair have the character that it does, while snowshoe hare is different in nature.

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

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

Special tactile hairs, the vibrissae, are found not only on a mammal's face but may occur also on the legs or elsewhere on the body. Nerves at the base of vibrissae communicate response to the brain. Humans do not have vibrissae.

Fig. Vibrissae on the porcupine and the pocket gopher and the fisher. Look at the mammals in the Lab for presence or absence of vibrissae.



Note the location of vibrissae on specimens of a variety of mammals in relation to the habits and/or habitat of each species. Among the animals you could look at are the woodchuck (Marmota monax), pocket gopher (Geomys bursarius) and Otter (Lutra canadensis).

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

Bright color are rarely found in mammals; most mammals are nocturnal and most are color blind. The Squirrels are another diurnal and somewhat colorful group, but they do not match birds in coloration.

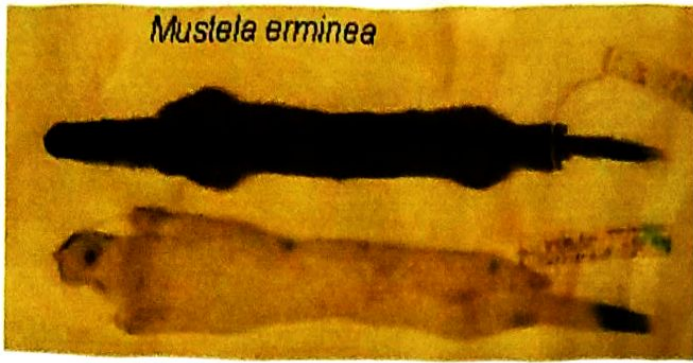
The color of an individual hair mainly depends on the kind and concentration of pigment granules in the cortex. The different pigments are not evenly distributed over the length of each hair. Look at some of these hairs under the microscope or with the eye.

hair Replacement.-

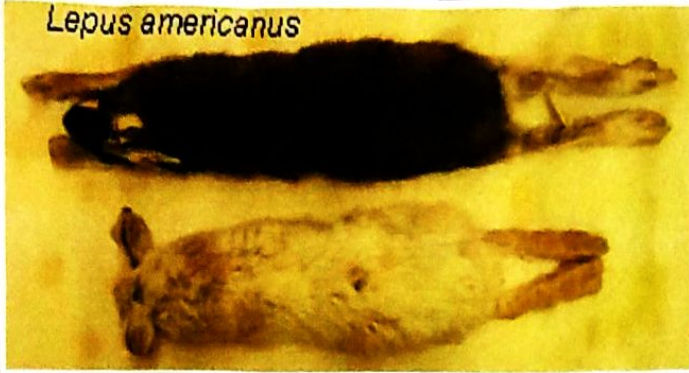
The pelage must be maintained to maintain its functionality. Hair cannot be repaired when damaged because it is nonliving. Most hair is of definitive growth and is replaced periodically. This process is called molting.

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

Mustela erminea



Lepus americanus

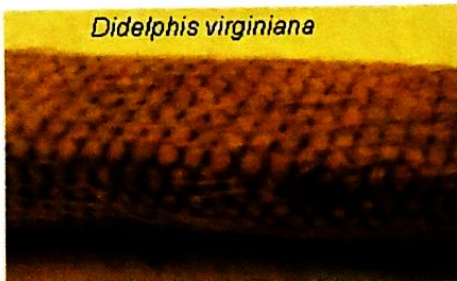


In many mammals there is a distinctly juvenile pelage that distinguishes young animals from adults. Members of the deer family are a good example of this, moose calves are reddish in color, for example. There is the skin of a white-tailed deer lawn in the laboratory, compare its hair to that of the adult deer.

Scales. - The scales on the more or less naked tails of rats, mice, and beavers are protective, epidermal thickenings of the skin made of keratinized cells. The thinner skin between these scales allows flexibility. They consist of keratinized cells and are in structure and development basically equivalent to hairs.

Fig:- Examine the scaly tail of a beaver or rat (*Rattus norvegicus*) or opossum (*Didelphis virginiana*) and note the placement of hairs in relation to the placement of scales.

Didelphis virginiana



Castor canadensis



The armadillo (Edentata: Dasypodidae) has both epidermal scales and dermal bone. The epidermal scales resemble the scales on the tails of the rats and 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. Dermal bone also arose in ancient fishes, the ostracoderms. Today dermal bones are found in some modern fish, in the shell of turtles, and in the skin of many lizards and crocodilians.

Horns and Antlers

Horns and antlers are found today only in two mammalian orders, Artiodactyla and Perissodactyla. Extinct mammals from other orders (including the Rodentia) also had cranial ornamentations. Five different kinds of head ornamentation are recognized, each occurring in a different family. These kinds can be distinguished by their location on the head and their mode of development. You should be able to distinguish true, pronghorns, and antlers.

Horns:- True horns are found in the family Bovidae (order Artiodactyla). True horns are always

unbranched and permanent and composed of two parts: the bony horncore and the horn itself.

The zones extend upward on all ward from the frontal bones. Horns are covered by a sheathing layer of keratinized epidermis, the horn. The horn grows from its base throughout the adult life of the animal.

Fig. Diagram of horn (DeBlase and Martin 1981) on the left, and the horn core and horn of a bison on the right. This specimen is available in the laboratory,

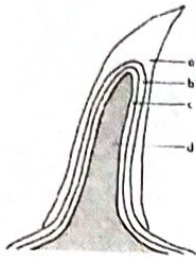


Figure 5-1. Diagrammatic section of a bovid horn: a, horn or keratinized epidermis; b, epidermis; c, dermis; d, bone.

Figure 5-2. gazelle, Ga



Examine horns and horn cores of the available bovids (cow, Bos taurus, and on wall bighorn sheep, Ovis canadensis and mountain goat, Oreamnos americana).

There are no cross-sections of horns in the UMD collection. Size, length, and curvature of horns varies among species.

pronghorns. -- The pronghorn (Antilocapra americana) of western North America is the only living species of the family Antilocapridae (Artiodactyla). As in the Bovidae the horn (properly called a pronghorn) has a bony core covered by a keratinized sheath and serves a similar function. However; unlike other horns, in pronghorns the sheath are (1) branched and (2) deciduous. Both sexes have pronghorns, but they are more prominent in the males. In females, the pronghorns sometimes are unbranched or absent altogether.

Fig. cross-section diagram of a pronghorn. (DeBlase and Martin 1981).

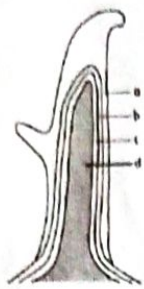


Figure 5-3. Diagrammatic section of a pronghorn: a, keratinized epidermis; b, epidermis; c, dermis; d, bone.

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 antlers themselves are shed after the mating season. The point of separation between pedicel and antler is the burr.

In Spring a new set of antlers begins to grow. The developing antlers are covered with a layer of skin and short hairs. This "velvet" carries blood vessels and nerves supplying the growing bone. Antlered animals tend to use their hooves for defense when attacked by predators.

Fig: Diagrammatic cross-section of a developing antler

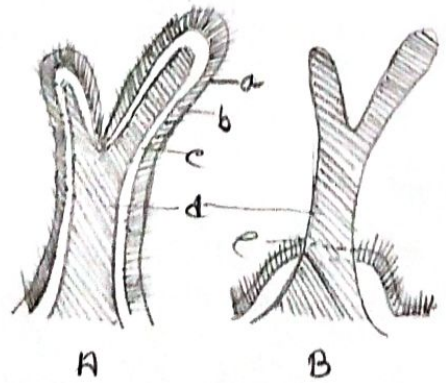


Fig: Sample skulls of deer (Cervidae) in the laboratory showing different aspects of antler growth.



Be able to distinguish to species the antlers of available cervids (mule deer *Odocoileus hemionus* and white-tailed deer *Odocoileus virginianus*; wapiti (elk) *Cervus elaphus*, moose, *Alces alces*, and caribou *Rangifer tarandus*; Moose antlers are palmated, while caribou antlers have a small amount of palmation and the brow tine. Wapiti antlers are larger than deer antlers and have a single beam that branches. White-tailed deer antlers typically curve forward and 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.

Fig. Drawing of different antler shapes and body sizes of extant members of the deer family in north and south America; Note the curvature on the white-tailed deer antler compared to the branching on the mule deer antler.



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Look at the skulls of male and female mouse, and also at the skulls of male and female deer. Note the abscission line and/or the pedicel.

Claws, Hooves, Nails

objectives, -- In this section we learn about claws, hooves, and nails of mammals. You should be able to identify and apply correctly all underlined terms.

The ends of most digits of mammals other than whales and most Sirenians are protected by hardened plates of the protein keratin. These plates take the form of claws, nails, or hooves. They are formed by the epidermis in a process similar to the growth of hair.

claws... The claw is the ancestral form of digitized covering. Mammalian claws are similar to claws of reptiles and birds. A claw is composed of a harden dorsal plate called the unguis and a softer ventral plate termed the subunguis. The subunguis is continued by the cushion like pad. Mammals like dogs and cats walk on these pads. In cross-section unguis and subunguis form a U-shaped structure with the unguis enclosing the subunguis. The downward curve is caused by a higher growth rate of the upper surface of the unguis. A claw is thicker in the median line than at the sides. The sides wear more quickly than the center, producing a more or less sharp point. In addition to the protection of the digits, claws are used in many ways for climbing, digging, hanging, or grasping and even killing prey.

Fig. Diagram of claws and nails.

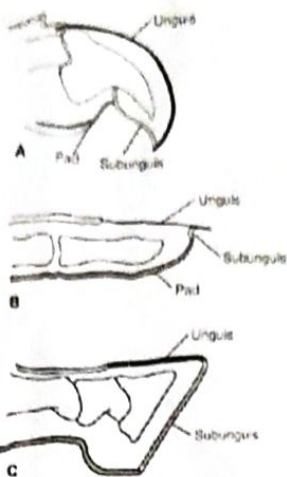
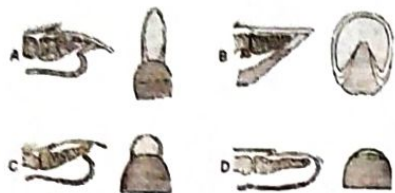
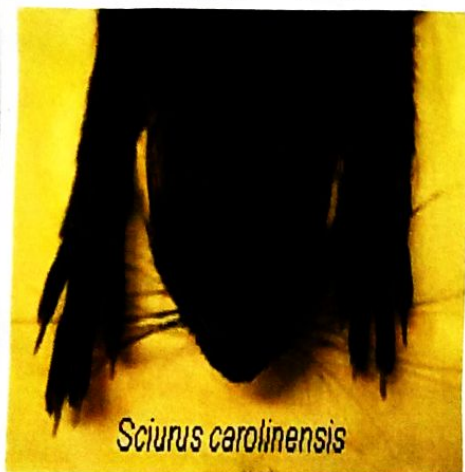


Figure 5.6 Claws, nails, and hooves. Similarities in the general structure but distinct variation with regard to specialized functions are evident for (A) claws, (B) nails, and (C) hooves. Top views of each part are lateral sections. Unguis is solid black, subunguis, light gray, and pad, dark gray.

Examine claws of an arboreal squirrel, cat dog, and a badger on more, locate the unguis and subunguis on each. what is the principal function of the claws of each of these mammals?

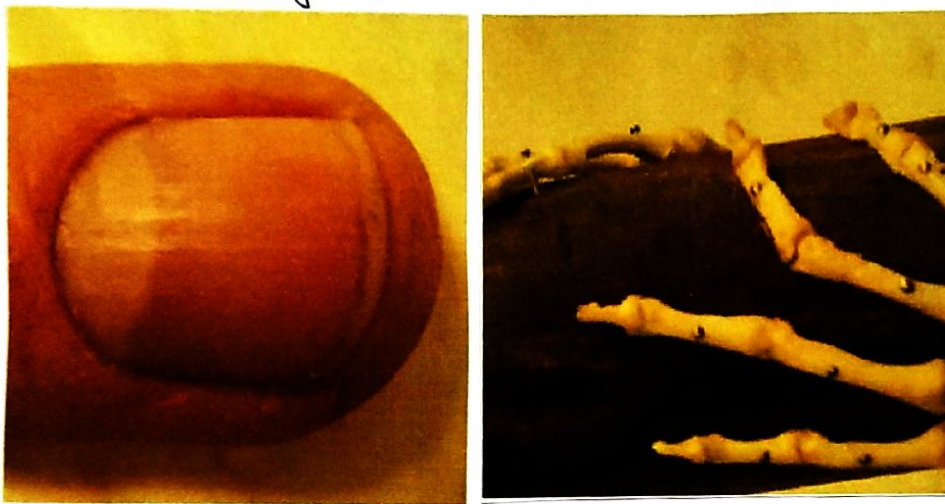
Fig. pictures of claws of several species that are present in the lab.



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 unguis is thinner and less rigid and the subunguis is very much reduced. A nail offers less protection than does a claw but exposes the end of the digit to permit more precise manipulation of objects.

Examine your own fingernail and locate the unguis and subunguis, compare with the nail of other primates - contrast with the claws observed above.

Fig. Fingernail of a human and the hand skeleton of a monkey, species unknown, compare your fingernail to the monkey present in lab.



Hooves. - well-developed hooves are found among extant mammals only in ungulates. They are further modified claws in which the unguis encloses both the end of the digit and the subunguis. The softer subunguis wears away more quickly than the unguis, thus forming a sharp edge. The pad lies just behind the hoof and is called the frog. In ungulates normally only the hoof, not the frog, is in contact with the ground.

Examine the hooves of the cow, white-tailed deer, and horse hooves in the laboratory. locate the unguis, subunguis, and frog.

Figure: picture of Odocoileus virginianus hooves that are available in the laboratory.



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



The following specimens are available in the lab today,
 other species will be available in the next labs.

| Order | 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 dorsatum</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 americanus</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 |
| | Leporidae | <u>Sylvilagus floridanus</u> | Eastern cotton tail |
| Lagomorpha | Leporidae | <u>Lepus americanus</u> | Snowshoe hare |
| Rodentia | Sciuridae | <u>Marmota monax</u> | woodchuck |
| Xenarthra | Dasypodidae | <u>Dasyurus novemcinctus</u> | Armadillo |
| Rodentia | Meridae | <u>Onychomys leucogaster</u> | muskrat |