Vampire bats are ***sanguivores***, organisms that feed upon the blood of other animals. They are the only mammals that feed exclusively on blood. They are very small animals, with wingspans of about 12-15 inches, and weigh less than 2 ounces. Common vampire bats (*Desmodus rotundus*) are found in Central and South America, and feed exclusively on mammalian blood. They preferentially feed on livestock animals such as cattle and produce venom components that disrupt the blood coagulation cascade, enabling a constant blood flow for feeding. However, there are reports of rare incidents of human interactions which have led vampire bats to become more medically relevant to humans. Outbreaks of rabies in human populations due to the vampire bats being vectors of the disease have led to anti-vampire bat campaigns and culling of bat populations.

Taxonomy:

Kingdom – Animalia
Phylum – Chordata
Class – Mammalia
Order – Chiroptera
Family – Phyllostomidae
Subfamily – Desmodontinae
Genera – Desmodus
Species – rotundus

SPECIES AND DISTRIBUTIONS

Three species of vampire bats are recognized. Vampire bats occur in warm climates in both arid and humid regions of Mexico, Central America, and South America.

Fig. Distribution of the three species of vampire bats.

Common Vampire Bat (*Desmodus rotundus*)

This species is the most abundant and most well-known of the vampire bats. *Desmodus* feeds mainly on mammals, particularly livestock. They occur from northern Mexico southward through

Central America and much of South America, to Uruguay, northern Argentina, and central Chile, and on the island of Trinidad in the West Indies.

White-winged Vampire Bat (*Diaemus youngi*)

This species feeds mainly on the blood of birds. They occur from Mexico to southern Argentina and are present on the islands of Trinidad and Isla Margarita.

Hairy-legged Vampire Bat (*Diphylla ecaudata*)

This species also feeds mainly on the blood of birds. They occur from Mexico to Venezuela, Peru, Bolivia, and Brazil.

The White-winged and Hairy-legged Vampire Bats are less abundant and less is known about these species than is known about the Common Vampire Bat, *Desmodus rotundus*.

BAT DESCRIPTION:

The Chiroptera is the second largest mammalian order with approximately 202 genera and over 1,120 of living species. The vampire bats are dark gray or brownish in color on the head and back with paler undersides. These bats generally have small ears and a short tail. Its front teeth are specialized for cutting and the back teeth are much smaller than in other bats. The dental formula is 2/3, 1/1, 3/3, 3/3 = 38 total teeth. Bats have evolved the largest hearts and lungs relative to body size of all mammals.

FEEDING:

Vampire bats find their prey by using a combination of smell, sound, and echolocation. They painlessly cut away a small piece of skin to let the blood flow. The tongue has an anticoagulant to keep the blood flowing and prevent it from clotting while they are feeding. They feed for about 30 minutes. Vampire bats do not suck the blood, but rather lap it up with their tongues.

HABITAT:

These bats reside in arid and humid areas like caves, hollow trees, old wells, mine shafts and abandoned buildings of the tropics and sub tropics in colonies in thousands. They share foods in colony. A vampire bat can only survive about two days without a meal of blood so when a bat fails to find food, it will often "beg" another bat for food. The "host" bat may regurgitate a small amount of blood to sustain the other member of the colony.

THE EVOLUTION OF BLOOD-EATING

Vampire bats are members of a large and diverse mammalian Family known as Phyllostomidae (New World Leaf-nosed Bats). At least 160 known species of bats are in the phyllostomid family. Most of the phyllostomid species feed primarily on fruit and other plant material, while others feed on insects, nectar, frogs, or are omnivores. Only the three vampire species feed on blood.

Recent genetic studies have determined that the vampires diverged from the remainder of the Phyllostomid family about 26 million years ago. Blood-feeding is thought to have evolved only once, in a common ancestor that is shared by the three vampire bat species of today.

Some researchers suspect that the first vampire bats may have evolved from insect-eating bats that were feeding on the parasites of birds and mammals. Thus, the bats were consuming a partial diet of blood (the blood that the parasites had eaten), and when they pulled the parasites off the bird or mammal, they were further exposed to blood at the attachment site. Behaviorally, it would not be a large leap for the bats to begin feeding directly on blood. This view is supported by observing other animals that feed in a similar manner. For example, although obligate (meaning compelled or constrained, required to survive) blood-feeding has evolved only once among vertebrates (vampire bats), some species of bird, such as the vampire finch, also feed on the ectoparasites of other birds and occasionally consumes some blood at the site where the ectoparasites were attached.

Research indicates that the vampires evolved from insect-eating bats to obligate blood feeders over a period of a little more than 4 million years. A tremendous variety of specializations occurred during that time, including the evolution of anticoagulants in the saliva, modifications to the teeth, physiological adaptations for digesting blood and excreting excess water, anatomical changes to facilitate preying on sleeping mammals or roosting birds, and sensory adaptations to detect prey and blood flow sites. The evolution of these traits undoubtedly involved many genetic changes to result in these unique and fascinating mammals.

Micronycteris

Desmodus

Micronycteris is a present-day example of an insectivorous bat. A similar bat may have given rise to the vampire bats approximately 26 million years ago.

By comparing the proteins expressed in the saliva of vampire bats, insectivorous bats, and medicinal leeches, scientists have shown that many of the salivary proteins important for blood-feeding, such as anticoagulants, are found in both vampire bat and leech saliva. One of the remarkable aspects of this discovery is that the evolutionary lineages that led to vampire bats and leeches diverged more than 500 million years ago, during a period of rapid origination of animal diversity known as the Cambrian Explosion.

Leeches and vampire bats, species that have been evolutionarily separate for 500 million years, share a common gene that has been modified, through a process known as gene recruitment, to serve a new function in the saliva of these species. This genetic change has resulted in the anticoagulant properties of leech saliva and vampire bat saliva that prevent blood from clotting at the wound site of a victim.

The term *gene recruitment* refers to the phenomenon of using genes that originally evolved for one function for a purpose in a new biological function. In the case of vampire bats (and leeches), genes have been recruited from normal hemostatic processes (that is, the regulation of blood coagulation) that are widely shared among animals, to novel roles as anticoagulants. For example, animals (including humans) express the protein version of a gene called **Entpd1** on the inside of blood vessels of the circulatory system. Normally, Entpd1 inhibits blood coagulation and helps to keep blood flowing through the circulatory system. However, when a person or an animal is cut or wounded, **Entpd1** is removed from the area of the wound by cells in that location. By removing Entpd1 from the wound site, blood clotting is allowed to take place. A wound created by a bite from a vampire bat, however, bleeds for a considerable amount of time. This is because Entpd1 is expressed in vampire bat saliva. So, even though the normal physiological response of the bitten animal is to begin blood clotting by removal of Entpd1, the presence of vampire bat saliva (and the vampire bat version of Entpd1) in the wound site prevents the blood from coagulating. This is an evolutionary adaption (by gene recruitment) to help vampire bats consume considerable portions of blood at a single feeding.

PHYSICAL ADAPTATIONS FOR FEEDING

Like most bat species, vampire bats use both echolocation and vision to navigate and find prey. They also use smell and sound to locate prey. Vampire bats, however, have evolved many unique characteristics for their specialized feeding behavior.

- Typical feeding behavior involves landing on the ground near its intended victim, usually while the individual is sleeping. Research has shown that in vampire bats, *an area of the brain that processes sounds has become specialized to detect the deep, regular breathing of sleeping animals*. The bat then climbs up the animal's body to find a suitable place to bite.

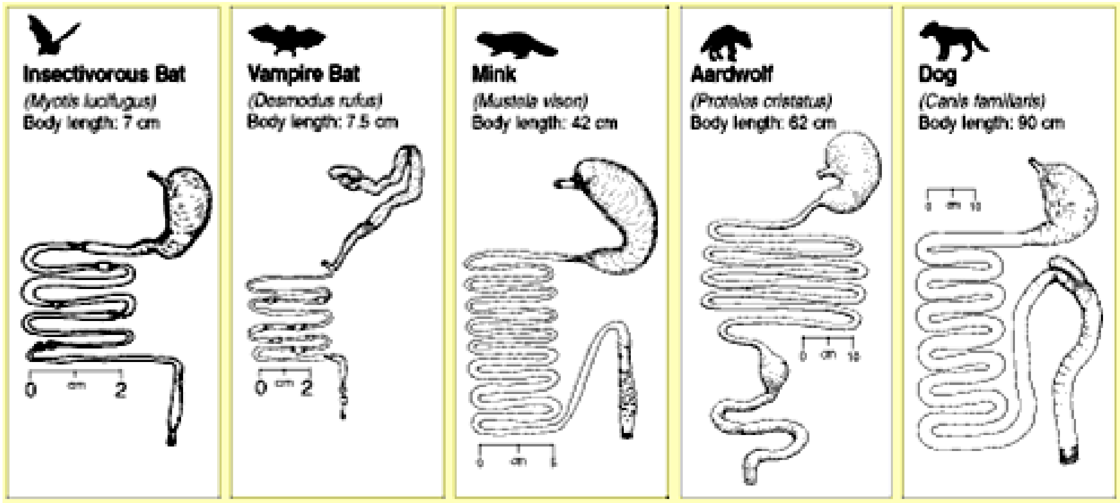
- Vampire bats have highly specialized *heat-sensing "**pit organs**" near its nose* that allow the bat to detect variations in body temperature due to blood flow near the surface of the skin. Vampire bat uses excitatory ion channels in its three sensory ganglia located by the nose to sense infrared radiation.

- The bat uses its *thin, broad, blade-like incisors* to make a very small incision (3-5 mm wide and deep) in the skin of its victim. The teeth are so sharp; the animal rarely knows it is bitten.

- The braincase of *Desmodus* is large and accommodates a highly specialized brain. The upper incisors and canines of *Desmodus* are large, flat, blade-like, and razor sharp for biting their prey. Unlike the teeth of most mammals, the teeth of vampire bats do not have enamel. This adaptation allows the teeth to stay especially sharp and not wear down from use.

- The bat does not suck the blood, but quickly laps it up with its ***specialized tongue*** that has two lateral grooves on the underside that expand and contract as the bat feeds.

- The *digestive tract, circulatory system, and kidneys* of the vampire bat are especially developed for rapid processing and digestion of blood. The stomach of a vampire bat is intricate and practically twice the length of its body. Vampire bat has an exceptionally muscular stomach that is much thinner and longer than any of the compared mammals. The stomach lining rapidly absorbs the blood plasma, and the plasma is transported quickly to the kidneys and then the bladder for excretion. A common vampire bat begins to excrete very dilute urine within two minutes of feeding. This shedding of much of the water-weight from a meal is necessary to allow the bat to fly and return to its roost.



- The limbs of the vampire bat also are specialized and different from those of other bat species. The *thumb of the wing is especially long and well-developed* and their *wings and hind legs are strong*. Unlike other bats, they can walk, run, and jump using their legs and the thumbs of their folded wings, and they are quite agile and stealthy. These abilities allow vampire bats to stalk and attack prey from the ground. The vampire bat's ability to jump almost vertically also allows it to launch its heavy body into flight after a large meal, when wing-power alone might not be enough for take-off!

- The bones of bats are long and very thin. The size and curvature of the bones in a bat wing make the wing lightweight and aerodynamic for flight. The curvature of the vampire bat's wings makes shape that tends to be more bowl-shaped that help to start flight quickly.

- The vampire bat is capable of walking forward, backward, and side-to-side (Riskin & Hermanson 2005) and running while other bats are incapable.

- *Anticoagulants in the saliva* of the vampire bat prevent the blood from clotting at the wound site. This anticlotting allows the blood to keep flowing until the stomach is full, a process that may take about 20 minutes. Vampire bats require about 20 grams (about 2 tablespoons) of blood per day, and they cannot survive more than two or three days without a meal.

  D. rotundus saliva or venom contains two important anticoagulant toxins: **Draculin** and **DSPA** (Desmodus rotundas salivary plasminogen activator). Draculin is a glycoprotein that irreversibly binds to factors IXa and X, and inhibits the conversion of prothrombin to thrombin. This prevents fibrinogen being converted into fibrin and thus inhibits coagulation of blood during feeding. DSPA components also aid in ensuring continuous blood flow by breaking up the fibrin mesh of any blood clots that are formed. Moreover, *D. rotundus* venom contains a compound similar in size and amino acid sequence to human **calcitonin gene-related peptide** (CGRP) which has potent vasodilatory properties. The vampire bat-derived form of CGRP (i.e., **vCGRP**) selectively relax arteriole smooth muscle by activating CGRP receptors and Kv channels that facilitate blood meal feeding by promoting continual blood flow.