



## FOOT NOTES

### AIM

To discover similarities in the different modes and means by which animals travel.

### INSTRUCTIONAL OBJECTIVES

#### **Students will be able to**

- Explain how the characteristics of a habitat influence the structure of an animal and its mode of locomotion, and how similar habitats pose similar locomotion problems.
- Recognize three basic types of foot stance and several different types of animal feet, and be able to describe how these feet function when the animal moves.
- State that, although habitats may pose similar locomotion problems for different animal species, each species has a unique way of solving these problems.

### MOTIVATION

Could you give a brief description of an animal's habitat and lifestyle if all you could see were its feet?

### MATERIALS

- Day I/Pre-Zoo Discovery Cards: *Where in the World . . .?* and *Foot Notes*, pre-zoo and zoo Student Worksheets; zoo map.
- Day II/Zoo Trip zoo map.
- Day III/Post-Zoo *Foot Notes* Discovery Card and worksheet (for reference), homework chart from previous night.



### LESSON PROCEDURE

#### Day I/Pre-Zoo

1. Have students develop lists of the countries on the different continents that contain the different habitats found on the *Where in the World...?* Discovery Card. Then they can locate assigned animals or exhibit areas on zoo map.
2. Have students review *Where in the World...?* card and complete pre-zoo worksheet.
3. Relate worksheet activity to zoo visit, and review locomotion categories.
4. Introduce *Foot Notes* card and zoo worksheet for next day.

#### Day II/Zoo Trip

1. Review the planned zoo route and go over zoo rules with class.
2. Briefly review cards and worksheets.
3. Have students conduct observations and fill in worksheets at exhibits (they should bring lists of countries).
4. Conduct optional zoo activity.
5. Discuss Homework activity.

#### Day III/Post-Zoo

1. Review zoo worksheets.
2. Work on post-zoo chart.
3. Conduct poetry activities or assign them for homework.

#### Summary:

Forests, grasslands, and deserts have certain basic characteristics regardless of the continent on which they are found. Because of this, many animals which live in different parts of the world share similar locomotion problems.

There are several basic types of feet found in land animals. In addition, many species have specialized foot adaptations that help them survive in a particular habitat. An animal's foot can tell us much about its mode of locomotion, habitat, and lifestyle.

### HOMework

1. After Day II, have students review the chart filled in at the zoo and make a new chart.
2. After Day III, poetry activities may be assigned for homework.



### NEW VOCABULARY

brachiation	plantigrade ( <b>plant</b> -uh-grade)
digitigrade (di- <b>git</b> -uh-grade)	stride
gait	trot
gallop	unguligrade (un- <b>gool</b> -uh-grade)

### LESSON PROCEDURE DETAILS

#### Day I/Pre-Zoo

1. Contact your zoo and confirm all trip arrangements. Obtain and distribute copies of the zoo map. Have the groups of students assigned to each world continent (from *Where in the World . . . ?*) locate animals from their continents on the zoo map. If your local zoo groups animals by habitat, have student groups locate animals by habitat categories instead. Involve students in planning a route through the zoo representing a variety of land habitats and continents. Review zoo visitor rules with the class.
2. Discuss the Motivation question and then ask: "How do the physical features of a natural habitat influence an animal's means of locomotion?" Distribute pre-zoo worksheets to each student. Refer students to the back of the *Where in the World . . . ?* card to help answer the questions. It is not expected that students will find all the answers on their own. See *Answers to Foot Notes/Student Worksheet #1 (Pre-Zoo)*.
3. Worksheet answers can lead to the question, "Do certain habitats dictate certain types of adaptations for locomotion?" (See *Technical Information*.) Explain that the class will use the zoo to find out if similar habitats have animals that share similar adaptations for locomotion. Review the basic locomotion categories of running, climbing, and burrowing.
4. Distribute the *Foot Notes* card and zoo worksheet. Have student groups read the cards and sheet. Explain that the card is to be used in filling out the worksheet. Foot stance is covered on the Discovery Card. "Stance" here refers to the position of the bones of the feet when the animal is standing or walking. If you wish, you may introduce the technical terms for these foot stances. (See **New Vocabulary**. Use of these technical terms is optional.)
5. Remind students of all the things they must bring with them for the zoo trip: zoo worksheets, continent list, writing materials. Students should have access to *Foot Notes* and *Where in the World . . . ?* cards for reference.

#### Day II/Zoo Trip

1. Follow zoo rules as to proper teacher/student ratio for your group size. Follow your pre-planned route through the zoo, taking the class to as many different types of LAND animals as possible. Try to include representatives of the different continents and of the animals listed in the **Technical Information** section. Do not emphasize birds, except for rheas, emus, ostriches, cassowaries, or kiwis. If the zoo has the following animals, make a special point to see them: hippopotamus, elephant, rhinoceros, camel, guanaco, llama, vicuna, or alpaca. They have unusual feet and are a challenge to classify. Let students make logical guesses as to their habitats (see **Technical Information**).



2. Review the cards, worksheets, and vocabulary with students before observing animals (perhaps en route).
3. At each exhibit, have students fill in the animal's name, its continent of origin, and its habitat on the worksheet. If zoo signs mention only a country and don't show it on the map, have students use their previously developed list of countries and habitats to determine from which continent the animal came. They may have to consult with each other to find which group had the country on its list. If the habitat is not mentioned on the zoo's signs, students can use the following clues to determine the habitat:
  - a) Hints in the exhibit (types of plants, soil, background art, etc.)
  - b) If there is a map showing the range of the animal, use the *Where in the World...?* card to try to match it with a habitat.
  - c) If the signs give the country of origin, consult the list of possible habitats for that country (developed previously) and make an educated guess. Some animals may live in several habitats. If so, note them all by letter (i.e., F = forest, G = grassland, and D = desert).
4. Caution students not to attempt to make animals move in order to see their feet. There are plenty of animals to see. If animals are not moving, or students cannot see their feet, move on to another exhibit and try to return later.
5. Have students spend a few moments at each exhibit to see how the animals move (especially climbing animals). It is difficult to tell if an animal is a toe-walker (digitigrade) unless it is standing, because it may rest as if it were flat-footed (plantigrade). Nearby graphics may show the animal in a standing position. If not, have students move on and, if possible, return later. Students can make additional notes on animal locomotion, using words defined on the back of the *Foot Notes* card. Confirm observations using **Technical Information**.
6. At the end of the zoo day, assign the following chart to students, using categories from the zoo worksheet. Ask them to notice if certain types of feet occur in certain habitats more often than in others. The completed table will be discussed in the next class session. (See **Answers to Homework Chart**.)

### HABITAT

	Forest	Grassland	Desert
Type of foot (from zoo chart)			
Flat-footed, etc.			

For each foot type listed in the left column of the chart, students should enter the number of species seen from each habitat represented at the zoo. For example: How many different flat-footed animals did the student find in the forest, the grassland, and the desert? (Note: If you think that your students will have difficulty completing the chart at home, it could be compiled as a class activity on Day III/Post-Zoo).



### Day III/Post-Zoo

1. Review the zoo worksheets and the homework chart assignment. See if students noticed any trends in their zoo data (see **Answers to Homework Chart**). Correlate the trends found at the zoo with the conclusions from pre-zoo day on the locomotion problems posed by each habitat.
2. Have students write limericks or cinquains about their favorite land animal at the zoo. IF possible, have them base their poetry on the animal's mode of locomotion. Refer to the format and examples in the *Rules for Poetry Assignment* section below.

#### *Rules for Poetry Assignment*

#### *Cinquain (sin-kane) rules:*

- one word title (animal's name or nickname)
- two words of description (adjective and noun or two nouns)
- three words of action (referring to locomotion)
- four-word phrase (about habitat, country of origin, or conservation)
- one-word summary

#### *Example:*

Tarantula  
Eight legs  
Waving, creeping, flowing  
Bird spider of deserts  
Dancer

*Limerick rules:* A limerick tells a story, usually humorous. It is a five-line poem in the following format: lines one, two and five should end with words that rhyme with each other. Lines three and four should also rhyme with each other. A title is optional.

Line one: 8 to 10 syllables  
Line two: 8 to 10 syllables  
Line three: 6 syllables  
Line four: 6 syllables  
Line five: 8 to 10 syllables

#### *Example*

#### *Hop-A-Long*

A kangaroo in the zoo loved to hop;  
It used its strong tail as a prop.  
Said the keeper, "Dear Roo,  
To remain in my zoo,  
Please hop, but not over the top!"

## Day I/Answers to Foot Notes and Student Worksheet #1 (Pre-Zoo)

See Worksheet attached at end of lesson.

Mode of Locomotion	Forest		Grassland		Desert	
	Advantages	Disadvantages	Advantages	Disadvantages	Advantages	Disadvantages
Climbing	4	12,13		3,11		3
Running	8	2,13,17	10,11,16	9	10,16	7
Burrowing	1	2 14,1,16			5,15	6,10

## TECHNICAL INFORMATION

### Day I/Pre-Zoo

The most efficient forms of locomotion in each habitat (general answers):

Forest: Climbing is the most efficient mode of locomotion in a forest, especially if the trees are close enough for branches to weave together. Most forest animals climb; some run or hop.

Grassland: Running is the most efficient mode of locomotion in a grassland. Most grassland animals run or hop and some burrow.

Desert: Running or hopping is the most efficient way of moving across a desert for the same reasons as it is in grasslands — open space with few obstacles. Burrowing is also important to survive extreme dryness and temperatures, or attack from predators. Many desert animals have adaptations for running and burrowing.

### Day II/Zoo Trip

Foot Stances of Land Animals

#### Flat-Footed (plantigrade)

Alligators/crocodiles  
Amphibians  
Badgers  
Lizards  
Rodents\*

All primates\*  
Armadillos  
Bats  
Moles  
Scaly anteaters

Almost all marsupials  
Anteaters\*  
Bears  
Raccoons  
Shrews Skunks Turtles



#### Toe-Walkers (digitigrade)

Aardvarks  
Camels and relatives  
Dogs  
Genets\*  
Kangaroo rats\*  
Otters\*  
Some marsupials

All birds  
Civets\*  
Elephants  
Hippos  
Kangaroos and wallabies  
Rabbits and hares\*

All cats  
Coyotes  
Foxes  
Hyenas  
Mongooses\*  
Skunks\*



## Day II/Zoo Trip (continued)

### Hooved (unguligrade)

All antelope (includes gazelles)

All cattle (includes bison and buffalo)

All deer

All goats

All sheep

Giraffes

Horses and zebras

Peccaries

Pigs

Rhinos



#### *\*Special Foot Stance Notes:*

*Weasels, civets, genets, mongooses, badgers, skunks, and otters.* Are either plantigrade or digitigrade, depending upon the species.

*Kangaroos and kangaroo rats.* The back legs are digitigrade when hopping; at rest, the front and back legs are plantigrade.

*Giant anteater.* On its front legs, it walks on its knuckles.

*Gorilla.* Walks on the knuckles of its front legs.

*Rodents.* In many species, the front legs are plantigrade when walking, running, or hopping. Close observation of each species is needed in order to make a correct determination.

*Rabbits and hares.* Are plantigrade in slow movement and digitigrade when moving faster.

### Special Feet

*Camels* (including llamas, guanacos, alpacas, dromedaries, and bactrian camels) walk on their toes (digitigrade), which spread apart to aid in traction on the soft desert sands or rocky mountain grasslands.

*The following three animals have adapted special feet to support their large bodies:*

*Elephants* also walk on their toes (digitigrade). Their toes are spread apart. Beneath the toes is a pad of connective tissue which helps support their weight.

*Hippopotamuses* are technically classified as “semi-digitigrade” because they stand on the end bones of four toes. As in elephants, these toes have a pad of supporting tissue beneath them.

*Rhinos* are nail-walkers (unguligrade, or hooved) and stand on the very tips of three thick toes.



### Day II/Answers to Homework Chart

	Forest	Grassland	Desert
Flat-footed	***	**	**
Walk on toes	*	**	**
Hooved	*	***	**
Digging claws	*	**	***
Climbing claws	***		
Opposable toes	***		
Hopping feet	*	*	**
Prehensile tail	***		
Balancing tail	**	**	**

#### Key:

\*\*\* = Large numbers of species, for that habitat, should fall here.

\*\* = Some species also fall here.

\* = Only a few species here.

These trends should have been observed regardless of the country of origin.

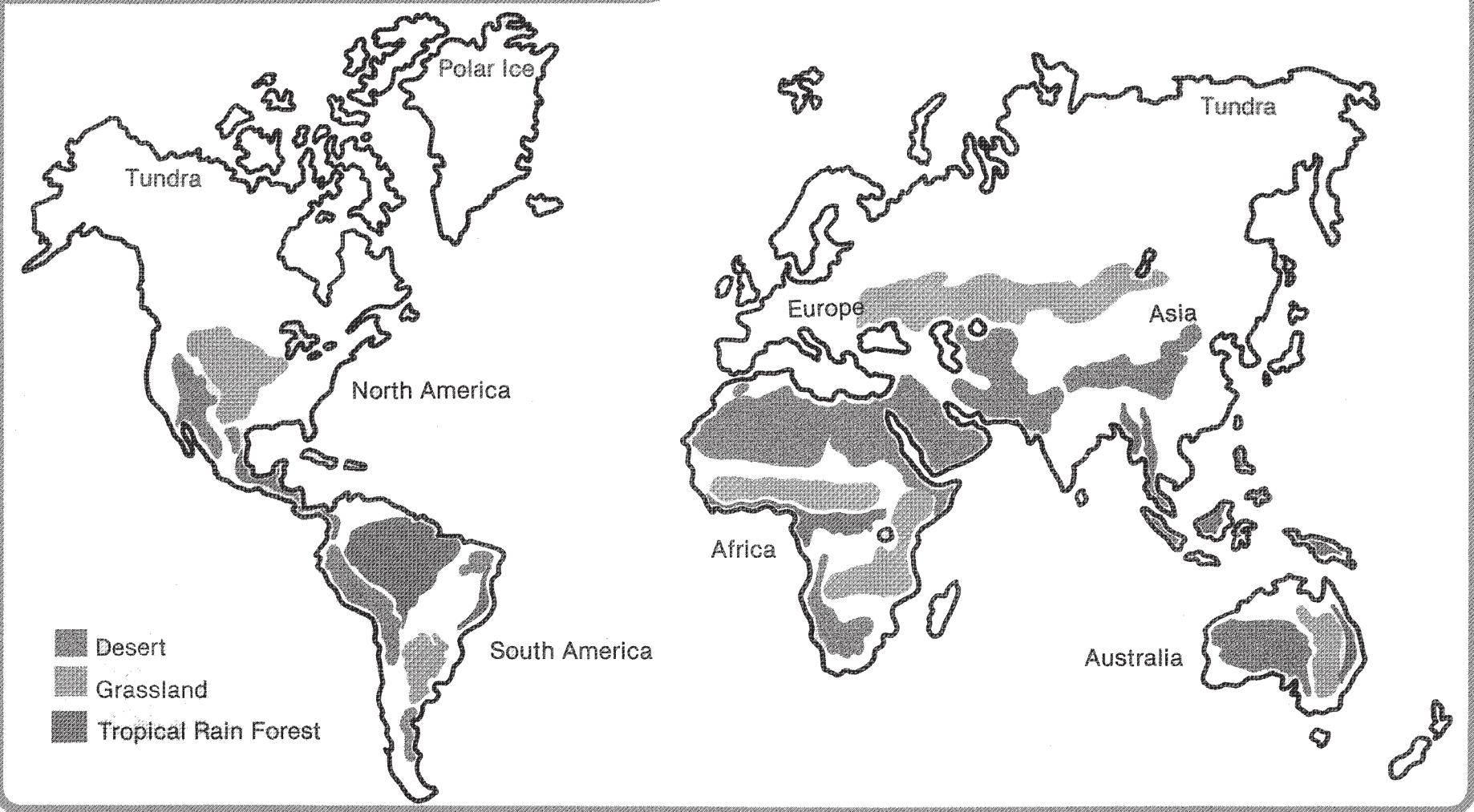
The zoo data should reflect a predominance of climbing adaptations in forests, running or hopping adaptations in grasslands and deserts, and burrowing adaptations in deserts (with some in grasslands). These are only general trends. When there are exceptions, it usually means an animal has developed special adaptations to overcome the survival problems posed by the habitat. You may wish to assign such an animal as a subject for extra credit study.

There may be several reasons why your zoo data don't agree with the given chart. For example, burrowers are not common in zoos because they are sometimes hard to keep in captivity and hard to view. Those that are kept in zoos may be mainly small grassland or forest animals. Your local zoo may concentrate on the animals of a particular habitat, or your route through the zoo may have been (inadvertently) biased toward a particular habitat. The main point is that animals are adapted to the survival problems posed by each habitat in different ways.

Adapted from *Wildlife Inquiry through Zoo Education: Diversity of Lifestyles* (grades 6-8)



# Where In The World



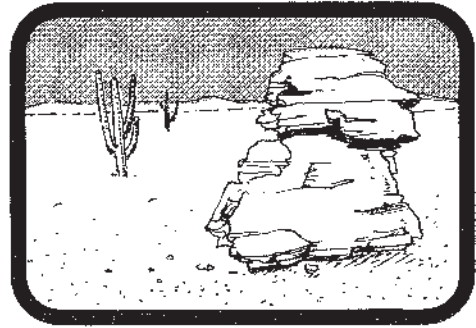
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Forest



Grassland



Desert

Each of the world's major habitats has its own unique combination of climate, plant life, and land forms (mountains, valleys, plateaus) which pose advantages and disadvantages to animal life. The plants provide food and cover, but they are often obstacles to locomotion for the animals that live in the habitat. The absence or presence of plants in a habitat can determine whether animals in that habitat climb, run or burrow.

**THE WORLD'S MAJOR HABITATS:**

**Forests:** habitats dominated by trees, in areas with abundant rainfall of 30 to over 100 inches per year. Climate differences around the world influence the amount of cover, food, and rainfall available to forest animals each season. There are different names for forests, depending on the kinds of trees they have.

**Temperate forests:** found in parts of the world where temperatures vary

seasonally. Some examples are:

**deciduous forest**—dense to open forest composed mostly of broad-leaved trees that shed their leaves at the approach of the cold season.

**coniferous forest**—composed of evergreen, cone-bearing trees. It is called **taiga** in northern regions and **alpine forest** in mountain regions.

**rain forest**—dense evergreen forest composed of either broad-leaved or coniferous trees that receive large amounts of rain.

**scrub forest**—composed of scattered evergreen trees that are resistant to a long dry season.

**Tropical rain forests:** dense evergreen forests composed of broad-leaved trees. They grow **near the equator**, have a warm, year-round climate, and receive abundant rainfall.

**Grasslands:** habitats dominated by grasses and non-woody plants in level

or rolling areas with 10 to 29 inches of rain per year. Some grasslands are wet enough to support scattered trees or shrubs. As with forests, climate differences all over the world make every grassland unique, and the many names given below are used to describe them.

**pampas**—an Indian word for the grassy plains of temperate South America east of the Andes mountains.

**prairie**—name for grasslands in North America.

**savanna**—tropical or sub-tropical grassland with scattered trees and drought-resistant plants; some of the largest stretches are found in Africa.

**steppe**—the Russian word for the vast, level, treeless grasslands of Europe and Central Asia; fairly dry and subject to extreme temperature ranges.

**Deserts:** dry habitats with less than 10 inches of rain per year. There are hot **and** cold deserts. Temperatures vary greatly, both daily and seasonally, as in

the Gobi desert of Asia. There is little vegetation available for food or cover.

There are other special habitats also shown on the world map. They pose their own special advantages and disadvantages.

**Tundra:** a level or rolling treeless area found in arctic and subarctic regions. The soil a few inches below the ground is permanently frozen, so even though there may be enough rain or snow per year to support big trees, the frozen soil prevents them from surviving. Dwarf species of trees, plus shrubs, grasses, mosses, and herbs make up the vegetation of the tundra. A similar habitat occurs on the tops of very high mountains and is called an **alpine tundra**.

**Polar Ice:** flat or rolling snow and ice present at the North and South Poles. Extreme cold and complete darkness for part of the year discourage all but a few animals from living in this habitat.



# Student Worksheet

## Foot Notes #1 Pre-Zoo

**INSTRUCTIONS:** Think about how an animal might move through a forest, grassland or desert using the methods of locomotion given below. What are the advantages and disadvantages of using each method of locomotion in each habitat? Use the numbered

answers below to fill in the chart. Some numbers can be used more than once. You can add your own answers in the blanks (#18 and #19) at the bottom and add them to the chart as well. Some boxes may be left blank.

Mode of Locomotion	Forest		Grassland		Desert	
	Advantages	Disadvantages	Advantages	Disadvantages	Advantages	Disadvantages
CLIMBING						
RUNNING						
BURROWING						

1. Moist soil sticks together and makes good tunnels.
2. Big tree roots fill the soil.
3. Only a few sturdy plants grow there.
4. Tall trees are strong supports.
5. Few plant roots in the way.
6. Tunnels in dry soil may collapse.
7. Sand is easy to sink into in some deserts.
8. Only have to run a short distance to cover.
9. There are many holes in the ground dug by burrowers.

10. Dry soil may pack down hard like cement in some places.
11. Grasses bend over easily.
12. Falls from heights can be fatal.
13. There are many plants in the way.
14. A lot of grass roots are available in the soil.
15. Sand is easy to dig into.
16. Wide open spaces.
17. Small animals can't see very far ahead.
18. \_\_\_\_\_
19. \_\_\_\_\_



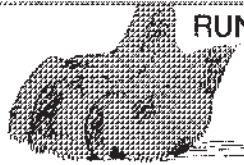
# Foot Notes

## RUNNERS – SLOW



Flat-Footed

## RUNNERS – FAST



Toe-Runners



Nail-Runners

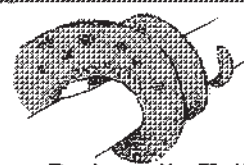
## CLIMBERS



Opposable Digits



Climbing Claws



Prehensile Tail

## BURROWERS



Digging Claws

## HOPPERS



Long Hind Legs

Balancing Tail

### BASIC TYPES OF FEET

**Flat-footed** animals walk on palms and all bones of the feet below the ankle. This group includes climbers, runners, and burrowers. They are slow in speed compared to the other running animals below.

**Toe-runners** run on the bones of their toes. The wrists and ankles do not touch the ground as they run. Some of these animals can also climb or burrow. **All** birds are toe-runners.

**Nail-runners** run on the tips of their toes on hooves (thickened nails). No burrowers or climbers are in this group.

To these **basic types of feet**, several adaptations may be added for special types of locomotion.

### CLIMBING ADAPTATIONS:

**grasping digits** are fingers or toes capable of wrapping around a branch for a sure grip.

**climbing claws** are curved and sharply pointed, to dig into tree bark.

**prehensile tail** can be wrapped around a branch for support. It must be able to hold all or part of an animal's weight.

**balancing tail** is long and helps the animal maintain balance, but cannot grasp tree branches.

### BURROWING ADAPTATIONS:

**digging claws** are broad and blunt, used together to dig.

**broadened feet** are wide and flat paws that act like scoops or shovels. Sometimes fur or bristles help make the paws wider.

### HOPPING ADAPTATIONS:

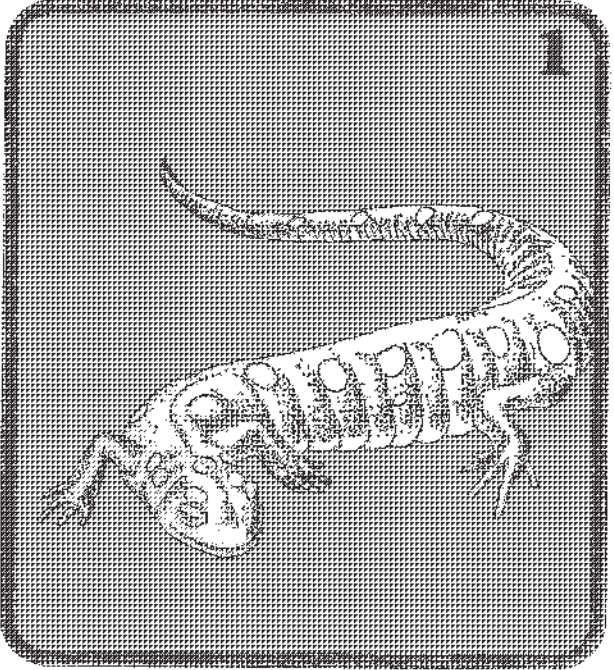
**hind legs** are longer and more muscular than front legs, and are moved as a unit. Such legs have long toes to help absorb the impact of hitting the ground during rapid hopping.

**balancing tails** are long and help the animal turn when running, and balance when standing.

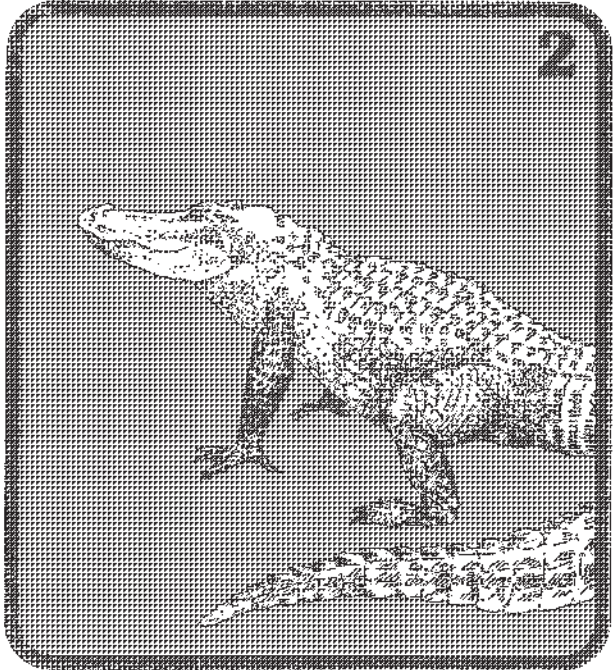
Animals that need four limbs for locomotion are found among amphibians, reptiles, and mammals. Yet, the leg positions and the way in which they are moved differ for each of these groups.

**LEG PLACEMENT**—A salamander is an amphibian. Its legs extend from its sides and barely lift it off the ground. This posture (1) slows the animal down and takes much energy.

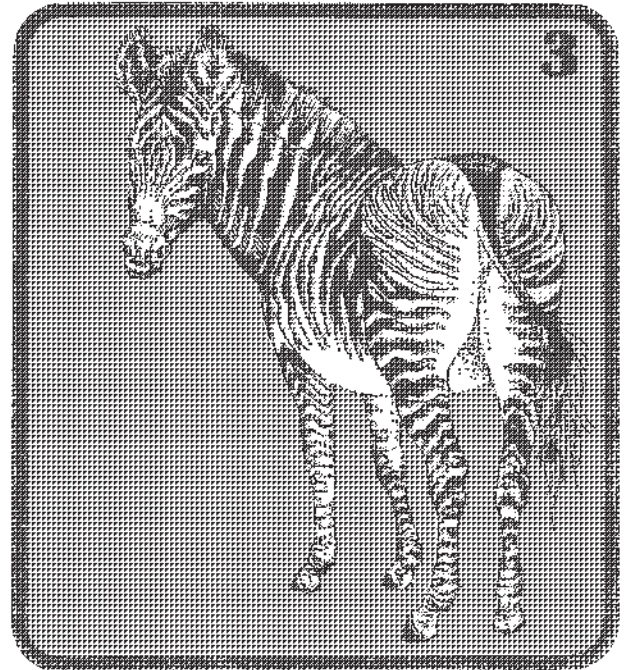
All reptiles except snakes have legs that extend from the sides of the body



Salamander



Alligator



Zebra

at the same or a slightly different angle than the salamander. But a reptile (2) can hold its body higher off the ground, and so it moves faster. A reptile can also move without the extra side-to-side movement of a salamander. This way of moving is more efficient and so saves energy.

Mammals have an even more efficient system of locomotion. Instead of legs that support the body from the sides, mammals' legs are located together **under** the body(3). This brings the body up and off the ground completely, so less energy is required for support. Mammals can move their legs forward and backward more freely by pushing the whole body off the ground.

Compared to reptiles, this increases the reach of their legs forward and backward (called a **stride**). Because mammals can keep their bodies up off the ground, they can run faster and farther, thus increasing their chances for survival.

**LEG MOVEMENT**—Watch how animals move their legs. Most four-footed animals have a **basic pattern**: the right forefoot moves first, then the left hind foot, the left forefoot and finally the right hindfoot (RF-LH-LF-RH). Some animals, like giraffes and camels, swing both legs on one side of the body forward together, then the legs on the other side of the body (RF-RH-LF-LH).

Have you ever slapped your hands on your legs to mimic the sounds of a running horse? Notice the rhythm of the beats. These rhythmic beats are called a **gait**. Many animals have different **gaits**. A gait is a rhythm and sequence of foot movements. Many animals are capable of changing their gait when they change speed. When a zebra **walks**, two or three feet stay on the ground all the time, and legs are moved in the basic pattern mentioned above. In a **trot**, two of the zebra's feet (RF-LH) touch the ground, then all four feet are off the ground for a split second, then the other two feet (LF-RH) touch the ground. When a zebra **gallops**, it puts only one foot on the ground at any one time in the sequence LF-RF-LH-

RH, then all four legs are up off the ground for a second or so. By changing gait, an animal keeps its body up off the ground for as long as possible, thus moving faster. This is an adaptation for survival.

Even climbing and burrowing animals have different gaits. Some animals use all four limbs to climb; a few use only two. Gibbons and orangutans move through the trees using only two front limbs hand over hand, while the hind limbs help balance and support the animal. This is called **brachiation** (BRAY-KEY-ASHUN). Carefully observe and record the way land animals move at your zoo.



**AWARD  
WINNING!**

# There's a connection between... Monkeys and Math Snakes and Science Lions and Language Arts

Find the connection for your students by participating in a Bronx Zoo Education Department *professional development* program, including:

**Workshops:** We help teachers bring new excitement to their classrooms through staff development workshops (K-12). Workshops are available at the Bronx Zoo as well as in host zoos and school districts nationwide. A rich array of standards-based activities and materials prepare teachers to make science alive for their students. Graduate credit available.

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