

LIFE ON EARTH UNIT FIVE SUMMARY

UNIT ONE MATERIAL

The videotapes to watch for this unit are:

- Video Program 9 - THE RISE OF THE MAMMALS
- Video Program 10 - THEME AND VARIATIONS
- Video Program 11 - THE HUNTERS AND THE HUNTED

Read the **CONCEPTS** in the study guide:

- CONCEPTS FOR EPISODE 9
- CONCEPTS FOR EPISODE 10
- CONCEPTS FOR EPISODE 11

Answer the **QUESTIONS** in the study guide:

- QUESTIONS FOR EPISODE 9
- QUESTIONS FOR EPISODE 10
- QUESTIONS FOR EPISODE 11

OVERVIEW OF LEARNING OBJECTIVES

Video Episode 9

To become acquainted with:

1. characteristics of mammals
2. differences between egg-laying mammals, marsupials and placental mammals
3. characteristics of egg-laying mammals (monotremes)
4. characteristics of marsupials
5. the effect of moving continents upon the evolution of mammals
6. advantages of reproductive methods used by marsupials & placental mammals

Video Episode 10

To become acquainted with:

1. insectivores, bats, whales and dolphins
2. adaptations demonstrated by these groups of mammals, particularly specializations that allow these mammals to occupy a particular habitat or utilize specific resources
3. use of sophisticated sonar systems by the bats and whales

Video Episode 11

To become acquainted with:

1. relationship of predator and prey species
2. adaptations of herbivores
3. adaptations of carnivores
4. rodents, rabbits, large grazing herbivores, horses, cheetahs, lions, hyenas
5. hunting strategies and defense strategies

CONCEPTS FOR EPISODE 9: THE RISE OF THE MAMMALS

MAMMALS

The line that leads to the mammals split off from the reptiles more than 300 million years ago. The earliest fossils that are definitely mammals are 170 million years old. The fossils in between are a source of controversy and the fight revolves around “how do you identify the earliest mammals”. One side says “220 million years ago”; the other side says “no, that’s a protomammal. True mammals are 170 million years ago.” The fossils exist but the interpretations vary because there is no evidence of hair or mammary glands on fossils.

In a land dominated by dinosaurs, the first mammals were small and shrew-like. The demise of the dinosaurs provided an opportunity for mammals to quickly diversify as new lifestyles and opportunities became available. Today, there are 19 groups of mammals.

Two main characteristics are present in all mammals: **hair** and **mammary glands**. Even whales and armadillos have hair, although their bodies may seem hairless. A thick coat of hair, called fur or pelage, is used as insulation. Mammals, like birds, are “warm-blooded” and produce their own internal body heat. The color and pattern of a mammal's fur can also provide camouflage as the mammal blends into its background. Animals use patterns to recognize members of their species. In fact, certain patterns may also allow mammals to recognize specific individuals, as has been suggested recently about zebra stripes. (Check out this PBS website to learn how zebras identify different members of the herd from the patterns their stripes make:

<http://www.pbs.org/wnet/nature/horsetigers/index.html>.)

Mammary glands produce milk, a fluid rich in nutrients which provides newborn mammals with food. The mammary glands are derived from a skin gland found in mammals, the **sweat gland**. The mammalian skin has two types of glands: the sweat gland and the sebaceous (oil) gland associated with the hair.

Other mammalian characteristics include (1) a muscular **diaphragm** below the rib cage that assists in breathing and (2) specialized **teeth** (incisors, canines, premolars and molars). As you will see in the video, the types of teeth are linked to the diets of the mammals. Many characteristics used to study fossil mammals and to separate the mammals into different groups are based on bones, especially teeth and skull structure. There is a practical reason for this. While hair and mammary glands may be lost in the fossil record, bony structures are often fossilized. Thus, a fossil can be determined to be a mammal based on unusual or unique bony structures. These bony structures include three tiny middle ear bones, a lower jaw made from one bone and a special type of joint that connects the lower jaw of a mammal to its upper jaw.

A good website for mammal species of the world can be found at:

<http://nmnhgoph.si.edu/msw/>

MONOTREMES, MARSUPIALS AND PLACENTAL MAMMALS

Mammals are generally divided into three types, based on their method of reproduction: egg-laying monotremes, marsupials with pouches and placental mammals.

Monotremes are mammals which lay shelled eggs. Many biologists feel that the monotremes are more similar to the early mammals than to the other living mammals. The monotremes are still mammals - they have hair and mammary glands. However, the mammary glands lack well-developed nipples so the offspring lap the milk off the mother's fur as it oozes from the mammary glands. The only living monotremes are the duck-billed platypus and two kinds of spiny anteaters (also called echidnas). The platypus is found only in Australia and spends most of its time in the water. The echidnas live in Australia or New Guinea. These spiny anteaters use their claws to dig and burrow for insects, especially ants and termites.

Marsupials are pouched mammals. Their young are born at a very early stage of development and must crawl up the body of the mother into the pouch. Once inside the pouch, the tiny marsupials attach to nipples and continue to develop outside the body of the mother. Marsupials evolved about 100 million years ago, probably somewhere in North America or possibly South America. Most modern marsupials are limited to Australia and isolated South American regions, except for our North American opossum. While marsupials, both living and fossil forms, exhibit great diversity, most apparently cannot compete well with the reproductive success of placental mammals. Some prove to be very adaptable, such as red kangaroos in Australia and the Virginia o'possum in the United States.

Placental mammals evolved about the same time as the marsupials. This group is characterized by the presence of the **placenta**, a vascular organ that connects the developing fetus with the female uterus. The placenta provides a link whereby an embryo is nourished throughout its entire development within the mother's body. The placenta delivers food and oxygen to the offspring while picking up carbon dioxide and waste products. As a result, the young mammals are much more developed at birth. This appears to dramatically increase successful survival of the young. (Remember natural selection from the first unit. One key to evolutionary success is to have more offspring which then in turn survive to reproduce.) Seventeen of the nineteen modern groups of mammals are placental mammals. You will see many of these placental mammals in the next three video episodes. Watch the video and look for advantages and disadvantages of the placenta.

References for mammals:

Kardong, Kenneth. 1998. *Vertebrates: Comparative Anatomy, Function, Evolution*, 2nd ed. McGraw Hill, Boston.

Raven, Peter H. and George B. Johnson. 1996. *Biology*, 4th ed. Wm C. Brown Publishers, Dubuque, Iowa.

5. When did the mammals as a group evolve?

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AUTHORS' NOTE: This date is now 170 mya for the earliest known mammalian fossil.

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6. a. How did early pelycosaurs regulate their body temperature?

b. What evidence supports the idea that the later pelycosaurs were warm-blooded (endothermic)?

c. Why are the pelycosaurs considered to be on the evolutionary line to mammals?

7. a. What information about diet and life style is suggested by studying the teeth of mammals?

b. Why do warm-blooded animals need more food?

8. When were these early mammals active? Describe the early mammals.

9. List the three methods of reproduction used by the mammals.

MARSUPIALS

10. Discuss the natural history of the opossum, particularly the development of the young.

11. What is the major characteristic of a marsupial?

18. How did the re-emergence of a land bridge between North America and South America affect the marsupials of South America?

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AUTHORS' NOTE: Biologists call this exchange of mammals between North America and South America the "Great American Interchange." You can find more information at:
http://www.flmnh.ufl.edu/ponyexpress/pony3_2/PE32.HTM
Then, click on "Fossil Horses and the Great American Interchange"

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19. Why have the marsupials flourished in Australia, in comparison to the marsupials in other parts of the world?

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AUTHORS' NOTE: Climate may be a contributing factor to the success of marsupials in Australia. Recent fossil evidence suggests that placentals were present in Australia but died out. Australia has had a hot, dry climate for a relatively long period of time.

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20. Describe the marsupial method of reproduction, as demonstrated in the marsupial mice.

21. Many marsupials have parallel counterparts with placental mammals. Briefly explain how the following marsupials differ from and/or resemble their placental counterparts. If there is no true counterpart, state that.

Marsupial	Placental
marsupial mice	
marsupial cat (quoll)	
Tasmanian devil	
thylacine	
numbat	
sugar glider	
koala	
wombat	
bandicoots	
honey possum	

22. What do the marsupials listed in question 21 eat?

Marsupial	Diet
marsupial mice	
marsupial cat (quoll)	
Tasmanian devil	
thylacine	
numbat	
sugar glider	<p style="text-align: center;">sap, blossoms, nectar, insects, arachnids, small vertebrates</p> <p>Reference: Nowak. 1991. Walker's Mammals of the World, 5th ed. John Hopkins Univ. Press, Baltimore.</p>
koala	
wombat	
bandicoots	
honey possum	

23. What is unusual about the tree kangaroo of New Guinea? How has it managed to survive?

Locator: caves of South Australia, near Adelaide

24. What was significant about the discovery of fossil bones in these caves? Describe the marsupial fossils.

25. Why did these marsupials die out?

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AUTHORS' NOTE: It has also been suggested that humans helped cause these extinctions.
See: http://news.nationalgeographic.com/news/2001/11/1112_overkill.html
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26. What brought about the change in the climate at this time?

KANGAROOS AND RELATIVES

27. What major body adaptation is seen in the kangaroo group, such as the potoroos, wallabies and red kangaroos?

28. What adaptations for an open grassland herbivorous lifestyle can be found in the kangaroos?

PLACENTAL MAMMALS

31. What is significant about the present-day mammal, the solenodon?

32. Describe the third reproductive method of the mammals: the placental mammals. What is a placenta?

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AUTHORS' NOTE: Mammals are amniotes, too. The placenta is derived from structures in the amniotic egg.
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33. What are the advantages to the placental method of reproduction?

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AUTHORS' NOTE: There are also disadvantages to the placental method of reproduction. Just watch a very pregnant woman waddling. And then, think about trying to escape from a predator with sharp teeth. The placenta is also more expensive in terms of energy expenditure.

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34. What are the two major physiological problems that had to be solved by the placental mammals in order to retain their young inside their body for a long period of time?

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Websites:

For information about monotremes, marsupials and placental mammals:

<http://www.ucmp.berkeley.edu/mammal/mammal.html>

For information about monotremes in Tasmania, see:

<http://www.medicine.utas.edu.au/research/mono/References.html>

For great information (and pictures) about monotremes in Tasmania:

<http://www.dpiwe.tas.gov.au/inter.nsf/ThemeNodes/LBUN-5362ZN?open>

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CONCEPTS FOR EPISODE 10: THEME AND VARIATIONS

This video episode looks at five groups of placental mammals: the tree shrews, insectivores, anteaters, bats and whales.

TREE SHREWS

Tree shrews are placed in a group by themselves (the Scandentia). Tree shrews probably resemble the first placental mammals to evolve (about 80 million years ago). Tree shrews are small mammals with big eyes that live in trees and catch insects.

INSECTIVORES

Insectivores are small mammals with pointy teeth. Their diet consists primarily of insects. Moles, shrews and hedgehogs belong to this group.

ANTEATERS

The anteaters are also called edentates. This group contains anteaters and armadillos. Many of the members of this group lack teeth; others have a few remnant peglike teeth. The members of this group are adapted to eat insects, primarily ants and termites.

BATS

All bats are grouped together as chiropterans. These are flying mammals that have evolved wings. Watch the video for an explanation of the bat wing and how it differs from the wing of a bird. Most bats eat insects; others eat fruit; still others have more specialized diets, such as the vampire bats you will see on the video. Most of the bats have a nocturnal lifestyle. Most bats use sonar to navigate. By the way, bats are NOT blind; they have excellent eyesight. Bats may be the closest living relative to the primates.

WHALES AND DOLPHINS

This group, the cetaceans, contains dolphins, porpoises and whales. These mammals are adapted to a marine lifestyle, which is reflected in their streamlined bodies. The front limbs have evolved into flippers; the back limbs are absent. They have a blowhole on the top of their head.

Whales come in two basic forms: **toothed whales** and **baleen whales**. The toothed whales obviously have teeth and actively pursue prey. An example of a toothed whale is the orca or killer whale. The baleen whales have sheets of whalebone (baleen) that hang down from their upper jaw; the baleen acts as a strainer to separate small fishes or crustaceans (krill) from the water. The tongue then licks the food off the baleen and the whale swallows the food. Baleen whales include the blue whale, humpback whale and right whale.

Recent molecular evidence shows the cetaceans are most closely related to the artiodactyls, which include pigs and hippos. There are also fossils that are whales with legs. In fact, recent fossil evidence shows that whales with legs had artiodactyl ankles (which are unique among mammals). For more information on whale evolution, see:

<http://www.ucmp.berkeley.edu/mammal/cetacea/cetacean.html>

<http://www.sciencenews.org/20010922/fob1.asp>

<http://www.neoucom.edu/DEPTS/ANAT/Thewissen.html>, then click on Whale Origins

5. Describe the star-nosed mole and its life style.

ANTEATERS

6. What specializations allow mammals to eat ants and termites? Which mammals have these specializations?

7. Describe the pangolins and their natural history.

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THREATS TO DIVERSITY: The ecological equivalents of the anteater in Texas are the horned lizard and armadillos. Horned lizard populations have declined substantially due to pesticides and the invasion of fire ants that kill off the native ants. Horned lizards will not eat fire ants and thus have less food to eat. For more information, see:

<http://www.tpwd.state.tx.us/nature/wild/reptiles/hlizrd.htm>

<http://www.hornedlizards.org/>

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8. Describe the following anteaters of South America:
a. giant anteater

b. tamandua

c. pygmy anteater

BATS

9. Why did bats become night-flying insectivores?

10. What ancestral mammal may have developed gliding and eventually gave rise to bats?

11. How old are the first fossil bats?

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AUTHORS' NOTE: This fossil is 50 mya but bat teeth have been dated to 58 mya. See:
<http://www.ucmp.berkeley.edu/tertiary/eoc/greenriver.html>
<http://tolweb.org/tree?group=Chiroptera&contgroup=Eutheria>

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12. What two changes in physiology or behavior allow bats to survive the winter?

13. Describe the navigational system used by the bats. How do they produce sonar?
What common body modifications improve their ability to echolocate?

d. fruit eating bat (also called flying foxes)

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AUTHORS' NOTE: Fruit-eating bats do not echo-locate. These bats, also known as megabats, may be more closely related to primates than the other bats, the microbats.

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17. Describe the flying foxes.

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THREATS TO DIVERSITY: In Thailand, flying foxes are considered aphrodisiacs and their wings are stir-fried. Decreasing flying fox numbers threaten the forests, because the flying foxes disperse the seeds of fruit. Flying foxes are not the only bats in trouble. For more information, including how to make your own bat house, see the Bat Conservation Inc. website below. You can also find information for the famous urban bat colony located under the Congress Avenue bridge in Austin by using their search engine.

<http://www.batcon.org> (Bat Conservation International)

<http://www.batcon.org/batsmag/v12n3-5.html> (flying foxes as food)

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18. Describe the wing of a bat. How is it supported? How does it differ from the wing of a bird?

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AUTHORS' NOTE: Pterosaur wings are a third variation of the same theme. The fourth finger is long to support the wing membrane. Check out the three variations at:
<http://www.ucmp.berkeley.edu/vertebrates/flight/converge.html>
If you want to see a pterosaur skeleton, you can go to the Texas Memorial Museum at UT Austin

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19. Describe the fishing bat of Central America. What changes have occurred in its body as a result of its diet?

WHALES AND DOLPHINS

20. What major event opened up the oceans for large mammals?

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AUTHORS' NOTE: Various animals besides whales and dolphins have gone back to the oceans, including the swimming sloth and the sea mink.

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21. Describe the adaptations to an ocean-living lifestyle that are seen in the humpback whales. Why are they so large?

22. Describe the changes in the whale's body that allow it to breathe more efficiently.

23. Describe the natural history of the humpback whale.

TOOTHED WHALES

24. List three animals that are classified as toothed whales. How do the toothed whales differ from the humpback whale in diet?

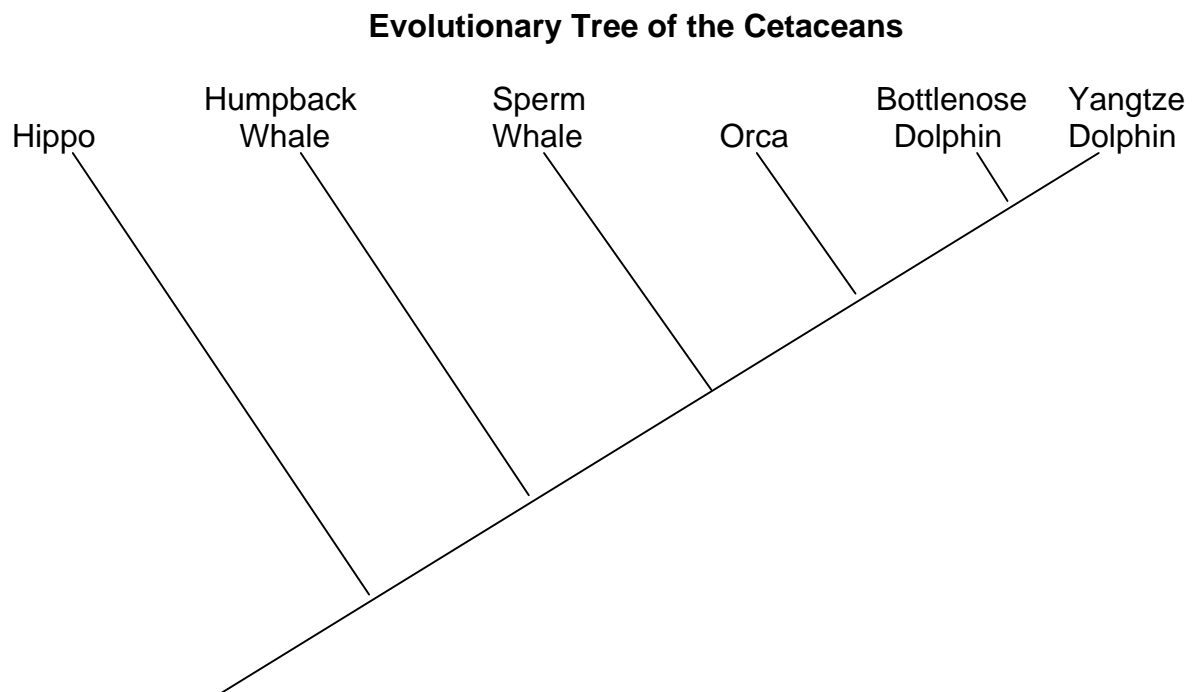
25. Describe the birth of a young dolphin.

COMMUNICATION

26. How do the dolphins communicate?

27. How do the dolphins find objects (and navigate)?

28. What is so unusual about the song of the humpback whales?



CONCEPTS FOR EPISODE 11: THE HUNTERS AND THE HUNTED

A VEGETARIAN DIET

Terrestrial herbivores eat plants. Plant cells have cell walls that contain a complex carbohydrate called cellulose. Animals do not have the enzymes necessary to directly digest cellulose. The animals that eat plants have symbiotic relationships with bacteria. The mammal eats the plant, the bacteria break down the cellulose: it's a win-win situation.

The trade-off is the need for time to digest. Imagine the digestive tract of an antelope as a large churning vat where bacteria digest the cellulose. As you will see in the video, the antelope then coughs up some of the plant matter from the vat, rechews it and swallows again. The reswallowed material then passes into a different compartment, where the mammal can begin the business of digesting and absorbing food once the cellulose has been processed.

While different herbivores have different internal arrangements for "where to put the bacteria", certain problems are almost universal. If you are a herbivore, you have to eat large amounts of plant matter, so you must have a large digestive tract. You have to have time to digest the plant matter. Eating grasses year after year will wear down your teeth, so you have to have a method of replacing worn out teeth. Finally, while it is a profitable way to make a business, you are also going to be fairly vulnerable to predators while you have your head down in the grass eating.

MAMMALS DISCUSSED IN THIS VIDEO

There are several groups of mammals in this episode. Let's look at a quick overview of the different groups.

Lagomorphs: rabbits, hares and pikas belong to the lagomorphs. They are adapted for jumping. They have four upper incisors which are nested (two in front of the other two) and lack canine teeth. (In the video, Attenborough uses the term "fang" instead of "canine".)

Rodents: mice, prairie dogs, capybaras, beavers, porcupines, rats and squirrels belong to the largest mammalian group, the rodents. These are small plant-eaters with four large incisor teeth. Incisors grow throughout the life of the rodent.

Carnivores: lions, cheetahs, hyenas, bears, weasels and wolves are carnivores. These are predatory animals that are adapted to a carnivorous, meat-eating lifestyle. Their teeth are adapted for shearing and cutting flesh. They have long canine teeth for killing prey. The video discusses different predatory lifestyles for several popular carnivores. Also included in the carnivore group are seals, sea lions and walrus. (These are apparently most closely related to the weasels!)

Artiodactyls: buffalo, antelope, deer and cows belong to the artiodactyls or "even-toed" hooved mammals. In other words, they either have two toes or four toes. These mammals are herbivores. Watch the video for details on their digestive tract and lifestyles.

Perissodactyls: horses, zebra and rhinoceroses are perissodactyls, or "odd-toed" mammals. These hooved mammals have one or three toes. Their herbivorous teeth are modified for chewing. Watch the video for details on the evolution of the horse.

Proboscideans: elephants belong to the group named for their long trunk or proboscis. Their two upper incisors are elongated into tusks. The elephants are the largest living land animal. The extinct mastodons and mammoths also belonged to this group.

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AUTHORS' NOTE: There is a cool web site on mammoths at these urls:
http://www.ucmp.berkeley.edu/mammal/mammoth/about_mammoths.html
<http://www.unmuseum.org/mastodon.htm>

You can also see fossil mammoths and other fossil proboscideans at the Texas Memorial Museum at UT Austin.

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QUESTIONS FOR EPISODE 11: THE HUNTERS AND THE HUNTED

1. The forests have remained virtually unchanged for _____ million years.

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AUTHORS' NOTE: This is an oversimplification. During this time period, the forests have moved around and the types of trees have changed. But the basic forest habitat has stayed relatively stable. In other words, it always looked like a forest with forest animals in it.

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2. Why is it difficult for animals to rely upon plants for food? How do the herbivores solve this problem? How do herbivores in areas with severe winters deal with the lack of food?

3. What happened 25 million years ago that promoted the spread of grasslands? Describe the grasses.

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CHANGING NATURE OF SCIENCE: Grasses were thought to have evolved first in South America about 50 million years ago. About 25 million years ago, they began to spread. However, there is new evidence that indicates that some dinosaurs fed on grasses, so they must be at least 65 million years old.

Websites: <http://news.bbc.co.uk/1/hi/sci/tech/4443696.stm>
http://news.nationalgeographic.com/news/2005/11/1118_051118_grass_dinos.html

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THE HORSE FAMILY

14. Describe the following changes that occurred in the animals that became the horses:

a. First appearance: 50 million years ago

b. Second major change: rise up on toes

c. Third change: middle toe for weight; side toes

d. Fourth change: loss of side toes

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Websites:

<http://www.flmnh.ufl.edu/natsci/vertpaleo/fhc/fhc.htm>

<http://www.talkorigins.org/faqs/horses>
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15. a. What member of the horse family inhabits the grasslands of Africa?

b. How does living in a herd provide protection?

RHINOCEROS AND ELEPHANTS

16. What adaptations found in the rhinoceros protect it from predators? What adaptations allow it to digest plants?

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Rhino Website: <http://www.rhinos-irf.org/> (endangered rhinos of Africa & Asia)
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17. Why is the adult elephant safe from predators? How do the elephants cope with the heat? What adaptations have occurred in the elephant that relate to its diet?

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THREATS TO DIVERSITY: Both rhinos and elephants are threatened throughout their range, mainly due to poaching. Poachers kill the rhinos for their horns (used for aphrodisiacs and dagger handles in the Middle East) and elephants for ivory and bush meat. There are other threats due to habitat loss and increased interactions with humans. Learn more at:
 <http://www.pbs.org/wnet/nature/elephants/>
 <http://www.pbs.org/wnet/nature/urbanelephant/index.html>
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25. Describe the hunting strategy of the hyenas. What is significant about their social structure and communication?

26. Describe the social structure of a lion pride.