UNIT 1
SNAKE BIOLOGY

Introduction to the Amazing Biology of Rattlesnakes

SECTION 1:
Ectotherms

Activity 1.1 Monstrous Appetites

Science and Technology - Life Systems	Grade 1: Characteristics and Needs of Living Things Grade 6: Diversity of Living Things Grade 7: Interactions within Ecosystems
Mathematics - Data Management and Probability	Grade 1 Grade 6 Grade 7

ECTOTHERMS!

INTRODUCTION

Reptiles require warmth just like us. Adequate heat is essential for proper digestion and other biological processes. They use different strategies to acquire heat, maintain heat, or alter body temperature. Reptiles make efficient use of their food energy, none of which is used to keep their bodies warm.

Ectotherms

Snakes are reptiles and all reptiles are ectothermic (ecto = from the outside, thermic = temperature). This means that they obtain body heat from their environment.

Mammals vs. Ectotherms

Mammals, such as humans, are endothermic (endo = from the inside, thermic = temperature) or warm-blooded. We control our body temperatures internally. To stay warm, mammals convert food into metabolic and mechanical energy. Relatively large amounts of heat energy are released into the atmosphere in this process. Therefore, mammals must continually eat; furthermore, mammals have to eat more than reptiles do. Reptiles require 90% less energy than mammals.

Behavioural Thermoregulation

The term cold-blooded, often used to describe reptiles, is misleading because the blood of a reptile is not necessarily cold. In fact, by varying their exposure to the sun or shade, reptiles can raise or lower their body temperature to maintain a prefered body temperature. This process is called behavioural thermoregulation. Snakes can also absorb radiant heat reflected off the ground or surrounding objects.

How do reptiles keep warm?

Basking in the sun is the most effective and common strategy reptiles use to keep warm. Rattlesnakes are often found on pathways, open rock areas, or in clearings, especially in the summer. Snakes can stay warm at night by seeking shelter under warm rocks, and can cool off during the day by moving into the shade. Physiological changes facilitate the transfer of heat to their bodies.

Why do reptiles need heat?

Snakes must increase their body temperature to obtain and digest food, excrete waste, and maintain respiration and circulation, functions that are essential to life. Their bodies must be warm to keep them active and alert. As well, female rattlesnakes use the warmth of the sun to incubate their internally developing embryos.

ACTIVITY 1.1
Monstrous Appetites

ISSUE
How do the energy requirements, food intake, and overall efficiency of mammals and reptiles compare?

BACKGROUND INFORMATION
Animals use energy gained from food for many different activities. Reptiles and mammals have different lifestyles and survival strategies. Lets compare reptiles and mammals…

Reptiles, such as snakes, save a lot of energy being ectothermic ("ecto"- from outside and "thermic"- heat). They do not use energy from their food to keep their bodies warm. This strategy allows them to use energy for essential biological functions such as metabolism (digestion, absorption, excretion), respiration, circulation, and reproduction. In fact, snakes require 90% less energy than mammals! Reptiles hibernate during the winter and do not eat during this period.

If you (a mammal) needed to eat 3 meals every day to stay alive, you would eat:
- 21 meals in a week (3 meals per day times 7 days per week)
- 90 meals in a month (3 meals per day times 30 days in a month)
- 1095 meals in a year (3 meals per day times 365 days in a year)

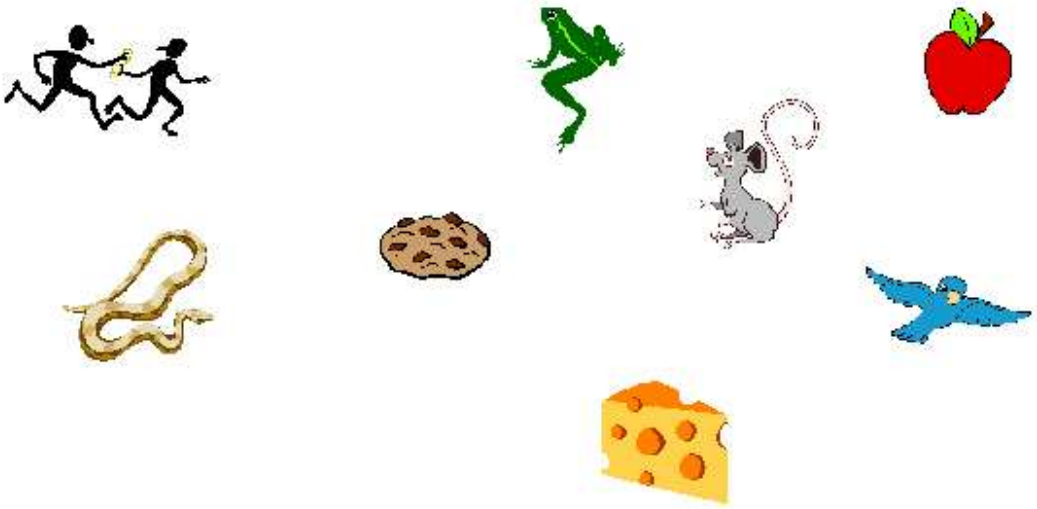
If a snake (a reptile) ate the same food but only needed to consume 10% of what you ate, it would eat:
- 2 meals in a week
- 9 meals in a month
- 110 meals in a year

Name:_____
Date:_____

ACTIVITY 1.1
Monstrous Appetites (Continued)

QUESTIONS

1. Draw lines to show what the people eat and what the snake eats.

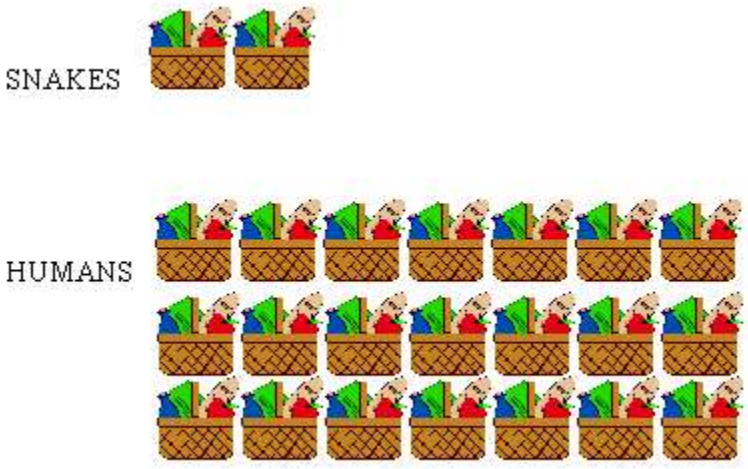


2. Look at the pictograph below and answer the following questions:

a) How many meals in a week does a snake eat? _____

b) How many meals in a week does a person eat? _____

c) Who eats more in a week (a snake or a person)? _____

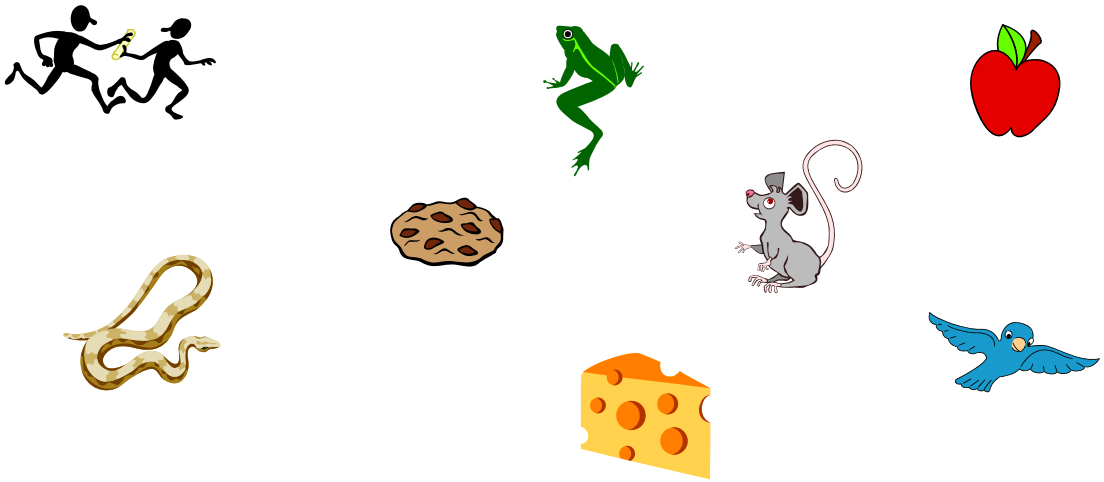


ACTIVITY 1.1
Monstrous Appetites (Continued)

ANSWERS

1. Draw lines to show what the people eat and what the snake eats.

Humans eat Apples, Cookies and Cheese.
Snakes eat Frogs, Mice and Birds



2. Look at the pictograph below and answer the following questions:

a) How many meals does a snake eat? ***TWO***

b) How many meals does a person eat? ***TWENTY-ONE***

c) Who eats more (a snake or a person)? ***A PERSON***

SNAKES 

HUMANS 

Name:_____
Date:_____

ACTIVITY 1.1
Monstrous Appetites (Continued)

QUESTIONS

1. Scientists gathered information on the number of meals snakes eat and compared these results to humans. Their results are shown in the table below:

	Humans	**Snakes**
Week	21	2
Month	90	9
Year	1095	110

a) Create a bar graph from these results. (Remember to include a title and label the axis.)

b) Looking at your graph, which type of animal makes most efficient use of their food energy (you or the snake)? Why?

_____
_____
_____
_____

2. Snakes are cold-blooded (ectothermic) animals. What does the term "cold-blooded" mean?

_____
_____
_____
_____

3. Using your knowledge about cold-blooded animals, why do snakes eat less food than humans?

_____
_____
_____
_____

4. A raccoon and a snake have landed on an island in Georgian Bay. If food were scarce, which animal would survive longer? Why?

_____
_____
_____
_____

ACTIVITY 1.1
Monstrous Appetites (Continued)

ANSWERS

1. Scientists gathered information on the number of meals snakes eat and compared these results to humans. Their results are shown in the table below:

	Humans	**Snakes**
Week	21	2
Month	90	9
Year	1095	110

a) Create a bar graph from these results. (Remember to include a title and label the axis.)
Student answers will vary.

b) Looking at your graph, which type of animal makes most efficient use of their food energy (you or the snake)? Why?
A reptile makes most efficient use of its food energy. (They are 90% more efficient than mammals.) It can keep warm by basking in the sun and can go longer between meals.

2. Snakes are cold-blooded (ectothermic) animals. What does the term "cold-blooded" mean?
Cold-blooded animals obtain heat from their environment.

3. Using your knowledge about cold-blooded animals, why do snakes eat less food than humans?
Snakes do not need to eat in order to maintain their body temperature because they use heat from the environment. As a result, they require less food.

4. A raccoon and a snake have landed on an island in Georgian Bay. If food were scarce, which animal would survive longer? Why?
If food were the only scarcity, the snake would have a better chance of survival than the raccoon because it needs less energy from the island's limited prey resource. Snakes do not need to eat in order to maintain their body temperature because they use heat from the environment. As a result, they require less food.

SECTION 2: Snakeskin

Activity 2.1: Making Scales!

Science and Technology - Life Systems	Grade 1, Characteristics and Needs of Living Things Grade 2, Growth and Changes in Animals Grade 5, Human Organ Systems Grade 6, Diversity of Living Things
Science and Technology - Structures and Mechanisms	Grade 1, Everyday Structures
The Arts - Visual Arts	Grade 1 Grade 2 Grade 5 Grade 6

Activity 2.2: Snakeskin Shedding Speedway

Science and Technology - Life Systems	Grade 1, Characteristics and Needs of Living Things Grade 2, Growth and Changes in Animals Grade 4, Habitats and Communities Grade 6, Diversity of Living Things
Health and Physical Education - Active Participation, Fundamental Movement Skills	Grade 1 Grade 2 Grade 4 Grade 6

Activity 2.3: The Great Snake Detective

Science and Technology - Life Systems	Grade 2, Growth and Changes in Animals

SNAKESKIN!

INTRODUCTION

Skin is very important to rattlesnakes because it offers physical protection and its colours provide camouflage. Snakes shed their skin as they grow. As a snake gets older, its growth rate slows down, followed by fewer sheds per year. Shedding also helps to replace the top layer of skin that gets damaged by day to day activity. This new skin offers better protection to the snake.

LAYERS

Snakes have three layers of skin. The outer layer is very thin and clear, providing the snake with extra protection. This outer layer is shed and replaced several times a year. The middle layer is thick and very tough. It contains thousands of hard overlapping scales, which act like armour. The scales overlap, providing leeway for expansion as the snake moves or when the snake consumes a large meal. The middle layer also grows the new skin before the snake sheds its old outer layer. The bottom layer of skin is the thickest and it contains the pigment that shows through the top two clear layers as distinct colours and patterns. The snake needs this pigment to hide itself in its environment.

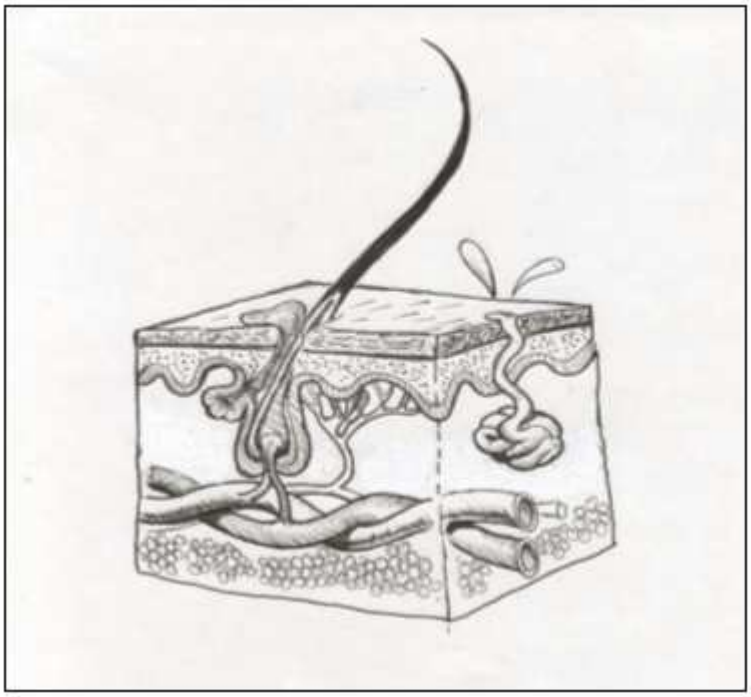


Figure 6: Human skin in cross-section

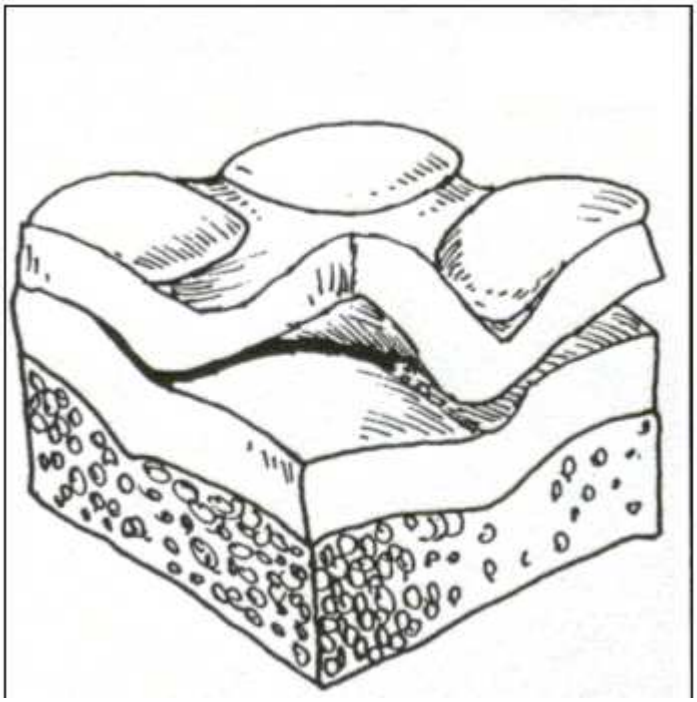


Figure 7a: Snakeskin in cross section

EYELIDS

Snakes have no eyelids and cannot blink. Their eyes are protected by a thin layer of skin called the spectacle. Spectacles are shed along with the outer layer of skin.

THE SHEDDING PROCESS (ECDYSIS)

When a snake prepares to shed its old skin, a milky liquid builds up under the outer layer to loosen it from the new layer of skin formed below. This milky film leaves a grey appearance to the snake's eyes and the dark belly scales on a rattlesnake. Snakes are vulnerable at this time and generally try to hide.

To begin shedding, the snake rubs its head against something hard to split the skin. By flexing its muscles, the snake stretches the outer skin and begins to wriggle out. The snake helps to pull the old skin back by curling around objects such as logs, branches, and stones. Eventually the outer skin is left behind, usually in one piece and inside out. The new skin is shiny and the snake's colours and patterns appear brighter than ever! Also, a new segment is added to the rattle each time a rattlesnake sheds - 3 to 4 times a year. You may find shed skins wrapped around logs, rocks, or near old building foundations. Shed skins are clear and engraved with the outline of every scale and fold of the snake's skin, including the spectacles that cover the eyes. The snake's pattern may also be visible on this discarded skin. Shed skins may be used to identify the snakes in a surrounding area.

Figure 7b:Each rattlesnake has a unique pattern. Toronto Zoo uses the shed skin to identify snakes

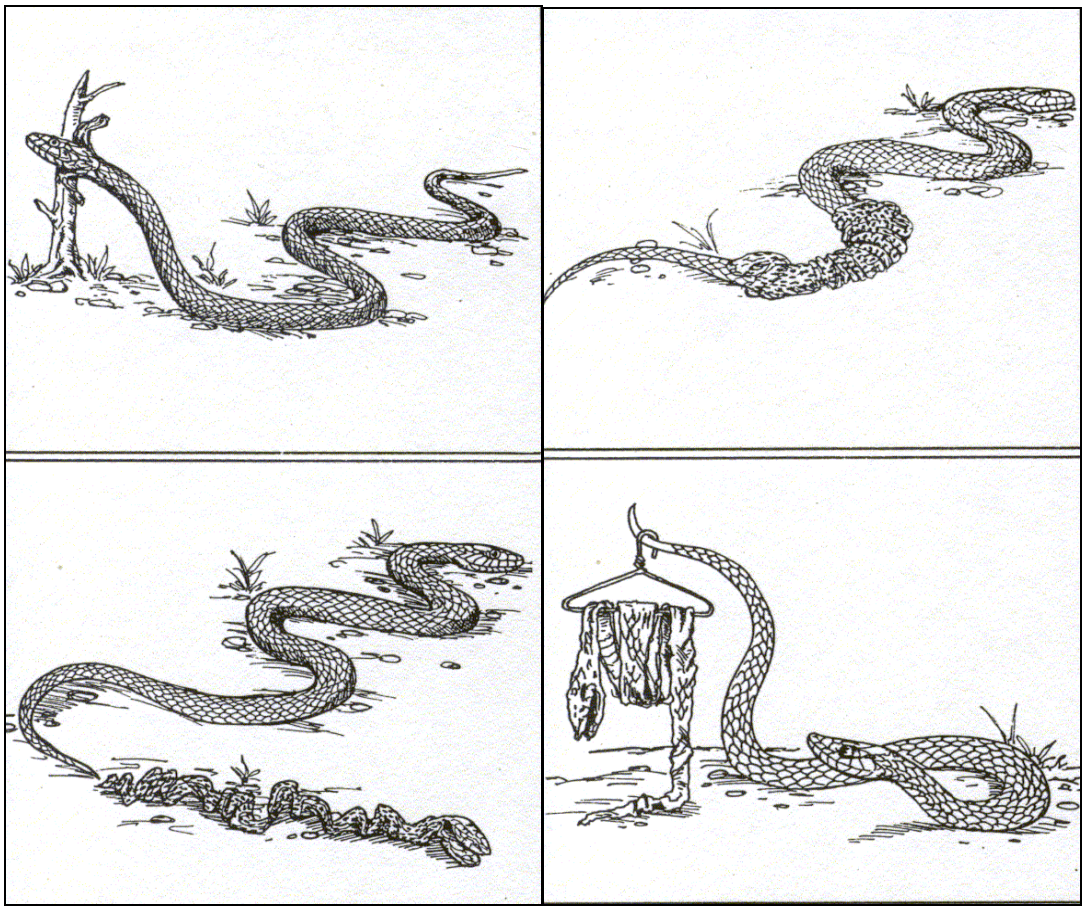


Figure 8-11: Snake shedding its skin. Note the use of natural objects to break and peel off the skin.

SCALES

All reptiles have scales, but not all scales are the same. Snakes can either have smooth scales or keeled scales. The kind of scales a snake has gives us an important clue in its identification. Smooth scales give the snake a shiny, sleek appearance. Keeled scales have a raised ridge along their mid-line, giving the snake a rough-textured appearance. Can you tell which kind of scale the massasauga rattlesnake has by its picture on the "Snakes of Ontario" poster? (The massasauga has keeled scales.) From the poster, make a list of all the snakes that have keeled scales, and all the snakes that have smooth scales.

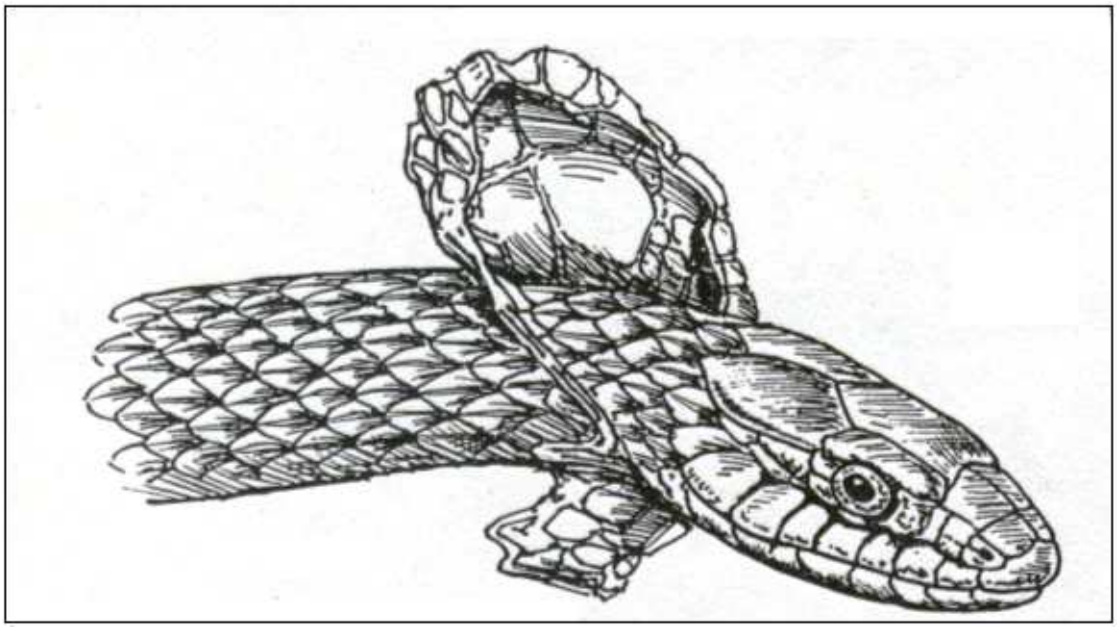


Figure 12: Snake shedding its head scales. Note the outline of each scale and spectacle.

SMOOTH SCALES

Northern Ringneck Snake
Smooth Green Snake
Blue Racer
Northern Water Snake

KEELED OR WEAKLY KEELED SCALES

Eastern Massasauga Rattlesnake
Northern Brown Snake
Northern Redbelly Snake
Queen Snake
Eastern Garter Snake
Northern Ribbon Snake
Eastern Hognose Snake

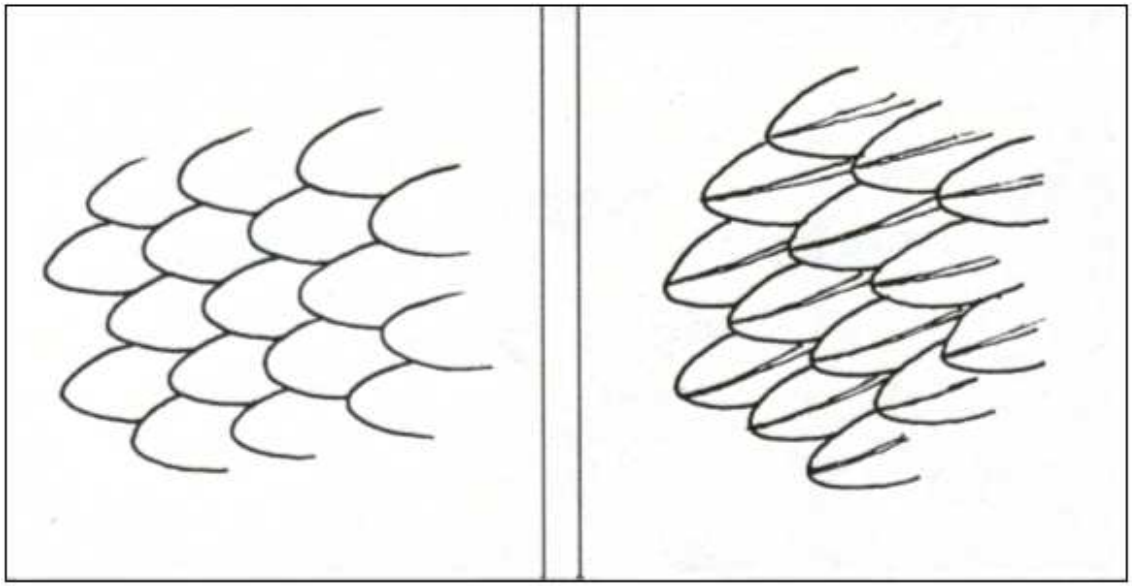


Figure 13: Smooth snake scales

Figure 14: Keeled scales of the massasauga rattlesnake

CAMOUFLAGE

Patterns on snakes help them to hide from their predators by blending into their surroundings or breaking up their shape in light and shadow. Colours and patterns also help us to distinguish one snake from another. Ontario's snakes can be grouped into three different pattern types: no pattern, striped, or blotched. Study the different patterns and colours on the "Snakes of Ontario" poster. How might these patterns help the snakes to hide in different habitats: peat bogs near Wainfleet, prairies in Windsor / La Salle; or forests and rocky outcrops on the Bruce Peninsula and around Georgian Bay.

Name:_____
Date:_____

ACTIVITY 2.1
MAKING SCALES

ISSUE

What are the different scale types found in Ontario snakes?

BACKGROUND INFORMATION

Snakes have *smooth* or *keeled* scales. Different types of scales help us to identify different types of snakes. In this activity students will make a snake with smooth scales, using pumpkin seeds, and a snake with keeled scales, using sunflower seeds, so that they can gain an understanding of the difference between the two.

MATERIALS

2 lumps of Play-Doh, Silly Putty, etc.
2 sheets of thin cardboard or heavy paper
1 package of sunflower seeds (with shells)
1 package of pumpkin seeds

METHOD

1. Roll out the clay into a snake shape, about 3 centimetres wide and stick it down on the cardboard.
2. Shape the head and tail. Add a tongue for fun!
3. Starting at the tail end, stick the sunflower seeds flat (broadside) down into snake's back. Put the seeds as close together as possible. The second row will overlap the first row. Continue adding rows of seeds until you run out of seeds (each student group may need to use only a handful of seeds to make comparisons).
4. Repeat steps 1 to 3, using pumpkin seeds instead of sunflower seeds, to create a second snake.

Name:_____
Date:_____

ACTIVITY 2.1
MAKING SCALES (Continued)

QUESTIONS

1. Compare the two snakes. How do they look? How do they feel?

_____

_____

_____

_____

2. Look at the "Snakes of Ontario" poster.

   a) Name a snake with smooth scales. _____

   b) Name a snake with keeled scales. _____

   c) What type of scales does the Eastern Massasauga Rattlesnake have? _____

ANSWERS

1. Compare the two snakes. How do they look? How do they feel?
   Answers will vary.

2. Look at the "Snakes of Ontario" poster.

   a) Name a snake with smooth scales. **Various Answers.**
   Examples: Eastern Milk, Northern Ringneck, Smooth Green, etc.

   b) Name a snake with keeled scales. **Various Answers.**
   Examples: Northern Water Snake, Eastern Hog Nose, Eastern Fox, etc.

   c) What type of scales does the Eastern Massasauga Rattlesnake have? **Keeled Scales**

ACTIVITY 2.2
SNAKESKIN SHEDDING SPEEDWAY

This fun game simulates skin shedding and incorporates some physical activity into the day (but you will need a bit of room).

The members of each group must line up one in front of the other, back to front. The first person in the line will be the snake's head, and the last person in the line is the tail. The "head" of the snake must bend over and put his/her right hand back between his/her legs. The second person bends over and grabs the "head's" right hand with his/her left hand, and puts his/her right hand back between his/her legs. The whole line or "snake" joins up in this fashion. (i.e. left hand reaching forward and right hand reaching backward.)

At the count of three, start shedding! The head of the snake begins to walk backwards, straddling over top of those crouched behind him/her. When the second person has been passed over, he/she then begins to straddle back over the rest of the snake's body, and so on until the snake's tail reaches the front and becomes the head. The skin is now shed!

Later, you can have skin shedding races between groups, or increase the challenge by combining the groups to make longer snakes.

Snakeskin Shedding Speedway Activity Set-up

ACTIVITY 2.2
SNAKESKIN SHEDDING SPEEDWAY (Continued)

Extension Exercise for Grades 4 and 6

This activity simulates skin shedding in a time and space efficient manner.

Have students put a long sock or stocking on one arm, pulling it all the way up to their biceps. These articles of clothing are used for protection and hug the body the same way as a snake's skin! Without using any hands (because snakes have no hands) "shed" the sock off, starting from the open end (mouth of the snake). Ask students to explore what objects (books, desks, smooth/rough surfaces, clothes, etc.) are most helpful with shedding their skin. Experiment with different objects and record the results. The sock should end up inside out, with the flip side of the pattern showing on the outside.

Students may be grouped into teams. Have contests to see who can shed the skin the quickest! Remember that the object you use to shed the skin with makes a difference.

Name:_____
Date:_____

ACTIVITY 2.3
THE GREAT SNAKE DETECTIVE

Rattlesnakes are covered with patterns and colours that help them hide from predators. This camouflage lets them blend into the environment. How many snakes can you find in the following picture? **See Appendix 3 to copy student activity sheet.**

Answer: 7 snakes

Section 3:
Snake Senses

Activity 3.1: Can You Find Me?

Science and Technology - Life Systems	Grade 1, Characteristics and Needs of Living Things Grade 2, Growth and Changes in Animals
Science and Technology - Energy and Control	Grade 1, Energy in our Lives
Science and Technology - Matter and Materials	Grade 1, Characteristics of Objects and Properties of Materials

Activity 3.2: Feel the Vibrations

Science and Technology - Life Systems	Grade 1, Characteristics and Needs of Living Things Grade 2, Growth and Changes in Animals
Science and Technology - Matter and Materials	Grade 1, Characteristics of Objects and Properties of Materials Grade 4, Materials that Transmit, Reflect, or Absorb Light or Sound
Science and Technology - Energy and Control	Grade 4, Light and Sound Energy

SNAKE SENSES

Let's compare how people and snakes make the most of their senses. This way, we can learn more about the environment in which snakes live. Humans have five senses: taste, smell, hearing, touch, and sight. Snakes use all of these senses too, but not always in the same way that we do. Rattlesnakes also have a sixth sense – their heat sensitive pit organs.

TASTE: Taste and smell often go hand in hand. Think of how bland food tastes when your nose is stuffed up with a cold. Little is known about a snake's ability to taste. We do know that tasting involves special receptors in the surface of the tongue.

SMELL: A snake flicks its tongue in and out to "smell" the air and gather information on where it is and what animals are around. Snakes use their sense of smell to find prey, other snakes, or familiar territory. The tip of the tongue picks up scent molecules and transfers them to a special organ in the roof of the snake's mouth (Jacobson's Organ). Signals are sent to the brain for interpretation. A snake increases its number of tongue flicks when presented with unfamiliar objects or new environments. Snakes can also use their nostrils for smelling.

HEARING: Snakes do not have ear openings on the outside of their heads but they can "hear" by feeling sound vibrations. Snakes have their heads on the ground and sound vibrations travel along their jawbones to the ears found inside their heads. The brain then interprets the vibrations. Sound waves do not travel far in the ground so snakes can only sense objects that are nearby.

TOUCH: Snakes are very sensitive to touch; a snakes entire body is able to feel, even though it has scaly skin.

SIGHT: Rattlesnakes have large eyes and their vertical pupils can open very wide. This helps them to see in the dark. But rattlesnakes can only see clearly for up to 4.5 metres. Rattlesnakes react to motion and will quickly move their heads towards moving objects. Snakes have one eye on each side of their head. This allows each eye to look in a different direction and see different things at the same time. Snakes lack eyelids so they cannot blink or close their eyes, even if they are sleeping! A clear scale called a spectacle protects each eye.

Rattlesnakes also "see" using their heat sensitive pits. All rattlesnakes are pit vipers; that is, they have special openings called pits between their eyes and nostrils. These pits allow the snake to detect heat from objects, even in complete darkness. The same way a thermal imaging camera detects a hot surface, the pit organs sense heat from the warm body of a prey animal and sends this information to the snake's brain. The snake then experiences a 'thermal image' of its surroundings. A great adaptation for hunting at night!

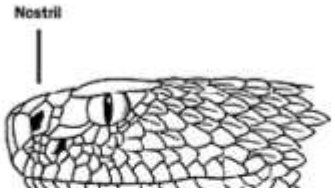


Figure 15: Snake tongue flicking

Facial pit

Figure 17: Vertical pupil and heat sensing pits between eyes and nostril

Figure 15: Snake tongue flicking

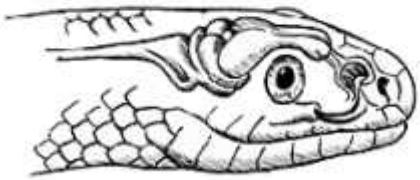


Figure 16: Jacobson's Organ

ACTIVITY 3.1
CAN YOU FIND ME?

These fun games will give students an idea of what it would be like to hunt using only heat sensitive pits.

Grade 1 - 3

You will need a small stuffed animal (preferably a mouse). One student will be the snake. Blindfold the snake and place the mouse somewhere around the group area. The snake can walk, crawl, or slither on its belly as he/she tries to locate and touch the mouse. The rest of the group says "WARMER" if the snake gets closer to the mouse or "COLDER" if the snake goes away from the mouse. These temperature cues represent the signals a snake receives from its heat pits. Once the snake finds the mouse switch roles and start again.

Grade 3 - 6

Fill four plastic beakers or cups with various temperatures of water; cold, cool, lukewarm, and warmer. (CAUTION: DO NOT USE HOT WATER!) Label the lukewarm beaker "SMALL MOUSE"; label the warmest beaker " LARGE MOUSE". Add equal amounts of perfume, vinegar, or another safe strong-smelling substance to the two warmest beakers - this smell represents a mouse. Blindfold one of the students in the group (he or she is the snake) and then move all of the cups around to different parts of the table. The snake must first use its nose to find the two beakers that could possibly be the mouse. Once the snake has identified these two beakers, it must keep its blindfold on and verify what it has found by touching the beakers to "sense" which is warmest. Make sure that everyone in the group gets to have a turn being the snake.

Note to teachers: These games can be easily adapted to be played by the entire class. An interesting variation would be to simulate the hunting method of another animal with an unusual sensory adaptation such that students are able to make comparisons. For example, to simulate how a bat hunts by echolocation, or a dolphin detects fish by using sonar waves, students could form a circle around a blindfolded dolphin searching for a hidden fish. The class could create a humming or other sound that would become louder, the closer the dolphin gets to the fish.

It is important to bring to the children's attention that:

- Snakes do catch prey during the day
- More than one sense is involved
- This exercise is not completely representative of a realistic situation

ACTIVITY 3.2
FEEL THE VIBRATIONS

This activity will help students to understand what it would be like to "hear" vibrations in the ground as a snake does.

Strike a tuning fork against a wooden desk or table. Gripping the fork's stem (DO NOT TOUCH THE PRONGS), hold the fork next to your ear and listen. Strike the fork again, but this time press the base of the stem against your jaw.

What happens? How does this relate to the way that a snake hears?