INTRODUCTION

(See Glossary of words highlighted in purple commencing on page 33)

When you think of a pond, you generally think of the green warmth of summertime and all the singing, swimming, flying, whirling, dancing, slithering creatures who live there. If you close your eyes and imagine a pond, you probably think of a frog croaking and the colour of a dragon-fly's wings; the wiggle of a tadpole or the waddle of a turtle.

A pond is teeming with life. It's a busy place. If you watch closely, there is movement everywhere: in the water, in the air, in the grasses around and on the pond's surface.

What happens to the pond in winter?

But what happens to all this life when the temperature plummets and the pond freezes up? We know that many birds fly to warmer climates and that bears and other creatures hibernate. Where do the frogs go? What do the turtles do? How do insects survive from one winter to the next? Do they hibernate? Do they freeze? How do they stay alive?

The answer to this question is both fascinating and complex. The truth is, different creatures use different strategies to weather the long cold winter. This unit will answer two important questions:

1. **How do pond creatures survive in winter?**

2. **Why doesn't a pond freeze all the way to the bottom?**

Before we start, an important thing to understand about many creatures who inhabit a pond is that they are cold-blooded. Unlike warm-blooded animals *(like people, squirrels, birds, rabbits, foxes and so on)*, cold-blooded creatures cannot internally regulate their own body temperature. This means that they are only as warm or cold as the air, water or soil in which the live. Have you ever seen a frog basking in the sun? You may look at him and think *"Ah, what a life".*

But the truth is the frog has no choice. If he gets too cold, he has to find a way to get warm or he won't be able to move! The scientific name for creatures who are cold-blooded is *Ectotherm*. (Warm blooded creatures are called *Endotherms*.)

So back to our question: How do ectotherms survive when temperatures plummet.

Question #1:

How do pond creatures survive in winter?

To answer this question, we're going to explore several different creatures:

Amphibians

- **Frogs, toads, salamanders**

*

Arthropods

- **Insects (**Dragonflies, bees, beetles, butterflies)

*

Arachnids

- **Spiders**

Fish

*

Reptiles

- **Toads, snakes**

* *illustration from Leon's Song by Dianna Bonder*

AMPHIBIANS

Frogs

There are basically two kinds of frogs:

- ***aquatic*** (those who live in and out of the water)
- ***terrestrial*** (those who live on land)

Aquatic and terrestrial frogs each have quite different strategies for surviving winter's frigid temperatures.

Aquatic Frogs

Frogs who live mostly in the water burrow into the soil at the bottom of the pond. Their ***metabolism*** slows down dramatically. Their hearts beat only once every few minutes. They crawl or swim, if at all, in slow motion.

Frogs breathe with their lungs just like we do and therefore they need oxygen to survive. In this ***torpid*** state, they need very little oxygen, but the little they do need is a matter of life or death. They get it from oxygen dissolved in the water which they absorb through their skin.

Food is no problem for the sleepy frog. They require no

more nourishment during 100 days of torpor than they do during one or two days of normal activity in the summer.

Tadpoles join their parents in this state of torpor in the mud at the bottom of the pond.

If these aquatic frogs spent their summer at a very shallow or temporary pond that might be in danger of freezing solid, they will migrate to a deeper pond or lake to overwinter. They will make their move to this deeper water during rain or high humidity.

These frogs stay out of deep lakes full of hungry fish (who would eat them) until they are ready to go into their torpid state. If they arrive early (before it gets cold enough for the lake to freeze), they hang out in the vegetation along the shore. Frogs that arrive later, when the weather is colder, swim far out to deep water, ready to begin their slow-down for winter.

As you will learn on page 29, the water in ponds, lakes etc. doesn't get any colder than 4°C. This is about the same temperature as your kitchen fridge. So next time you go get something out of your fridge, think about these aquatic frogs in winter!

Terrestrial Frogs

Terrestrial frogs generally find shelter under grass cover or leaf litter, because they can't dig underground like toads do. These hiding places, together with a thick layer of snow and the "heat sink" of the unfrozen earth beneath, can hold temperatures in the ***subnivean*** (under the snow) environment between 0°C and 5°C for long stretches of the winter. But still, you should ask, how do they survive such extreme cold. Afterall, water freezes at 0°C. Why don't the frogs freeze?

Well . . . they often DO freeze! Believe it or not, many frogs actually turn into "frog-sicles" during the winter. The Wood Frog, for example, regularly freezes sold in winter and thaws out in early spring, hopping away as if he had perhaps just paused for a little sleep. Spring Peepers, Gray Tree Frogs and Upland Chorus Frogs may freeze and thaw many times during the winter. When in its frozen state, the skin of the Gray Tree Frog actually turns blue!

So why don't these frozen frogs die?

Well, the short answer is that their bodies have adapted to create a kind of anti-freeze -- similar to the solution your parents may put in their cars in the wintertime to prevent their gas lines from freezing.

When ice begins to form on their skin, their body is trig-

gered to produce massive amounts of ordinary blood sugar or ***glucose***.

Nearly 2/3 of a frog's body water may exist as ice, but the ice is located in non-***vital*** areas such as the bladder, stomach cavity, beneath the skin, between organs and muscle fiber, and between cells. Importantly, the ice does not form within the living cells because the glucose acts like an anti-freeze by packing itself around these cells and protecting them.

When frogs are frozen:

- their eyes turn white because the lens freezes
- they have barely noticeable nerve activity
- they have no heart beat
- they do not breathe
- their blood does not circulate
- their vital organs do not deteriorate even after being frozen solid for several weeks

BONUS FACT: This triggered release of glucose is similar to the release of ***adrenaline*** in an animal's (including a human's) body when frightened or in danger. Have you ever noticed that when something scares you your heart starts beating faster? Well, this has to do with the release of adrenaline in your body. This release of adrenaline gives you a burst of strength for "fight" or "flight" -- that is, it will help you either fight or run away from the danger.)

Toads

Frogs and toads are easy to tell apart:

- The frog is an attractively marked animal with smooth skin and a streamlined appearance. It jumps well and swims fast.

- The toad is the opposite of a frog, with 'warty' skin, a muddy complexion and a chubby appearance. They are slow, buoyant swimmers and cannot jump well as their legs are too short – instead they walk!

During the winter, toads may dig down in the soil as much as 3-4 feet to stay below the frost line.

Salamanders

Salamanders lay their eggs near water in the fall, and then make their way down tunnels created by rodents or tree roots to spend the winter underground.

ARTHROPODS

Insects

In general, insects are able to survive cold temperatures most easily when the temperature is ***stable***, not ***fluctuating*** through alternate thaws and freezes. Blankets of snow benefit insects by insulating the ground and keeping the temperature surprisingly constant.

Specifically, however, insects have a variety of successful strategies for surviving winter:

- **Some insects winter as eggs:**
  - some eggs have thick shells to protect agains mois-ture and cold
  - some eggs have an outer coating of hair, silky threads or foam that provide insulation
  - a praying mantis is one example of an insect that lays eggs that survive the winter

- **Other insects hibernate**
  - these insects enter a resting state called ***diapause*** where they use very little energy (similar to bears and other hibernating animals)

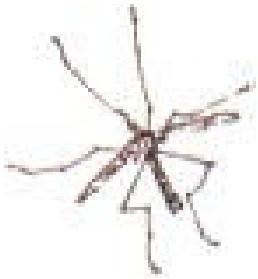
- The shorter days cue these hibernating insects to the fact that winter is coming (Note: it isn't the temperature which gives them this cue so they don't get tricked by an unseasonably warm or cold day)
- they hibernate in crevices and crannies under rocks, beneath leaf litter, inside the walls of homes, under eaves, in attics, under soil or burrowed in wood
- some examples of insects who hibernate as adults are some beetles, lady bugs and large wasps

- **Some insects avoid winter cold by migrating great distances to warmer climates**
  - the best known example is the monarch butterfly which travels as much as 2,000 miles to warmer climates (in Mexico or Southern California). If you were to find their hiding place, you'd see thousands of trees covered from top to bottom with a living carpet of half-asleep monarchs. Some trees have so many butterflies on them that the limbs sometimes break!

  - Some species of moths, dragonflies, ants, bees, wasps and lady bugs also migrate

- **Some insects winter as immature forms such as *larvae, pupa* or *nymphs***
  - the nymphs of some dragonflies, mayflies and stoneflies lie in waters of ponds and streams, often beneath the ice. (The majority of adult dragonflies will die at the onset of winter.)

  - these nymphs or larvae feed actively and grow all winter to emerge as adults in early spring
  - Goldenrod Gall Flies deposit their eggs at the tip of emerging goldenrod flower stems. The larvae live and grow inside the stems, causing the plant to produce a large, spherical ***gall*** on its stem.
- **A few insects (such as the winter crane fly, snow flies and winter stone flies) spend the winter as active insects**
  - these insects take advantage of the fact that their competitors and predatores are absent



- **Certain honeybees spend the winter in their hives**
  - they keep warm by huddling together against the cold. The colder it gets, the closer they huddle.

  - To create heat, they'll vibrate their wing muscles
  - Each bee takes turns being on the outside of the group
  - They consume up to 30 pounds of stored honey during the winter months (that's like 3 sacks of potatoes!)

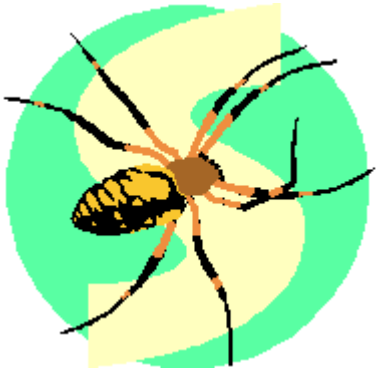
- **Some insects produce glycerol which acts like an anti-freeze and protects them from the winter cold**
  - this doesn't prevent them from freezing, but it does decrease the formation of ice crystals in the body as the water content of their bodies is decreased and the concentration of gylcerol increased

  - glycerol is a sugar alcohol similar but different from the glucose that land frogs use. Glucose is the normal blood sugar of all vertebrate animals.
  - caterpillars and pond-skaters (or water-striders) are examples of insects who produce glycerol. Pond skaters over-winter in shoreline debris beneath bark, in hollow plant stems etc.

- **Some water-dwelling insects burrow into lake and river bottoms for the winter**
  - some species of dragonflies live longer than a year and hibernate in deeper water during the winter
  - Adult diving beetles can bury themselves in the mud at the bottom of the pond during very cold winter weather.

ARACHNIDS

Spiders



Most spider species have a lifespan of a single year and thus rely on eggs to perpetuate the species from year to year.

85% of spiders who do live longer than a year spend winter in leaf litter which provides insulation from the cold. Throughout this period, their legs are tucked up and wrapped around their body so that the parts of their body exposed to the cold are as little as possible. Some spiders produce glycerol as an antifreeze (see page 12 for more information about how insects use glycerol as an antifreeze.)

FISH

Like aquatic frogs, fish tend to burrow into the stream bottom, getting underneath stones and woody debris. They might look for groundwater springs where the water is a little warmer, or try to stay in pool areas where the water ***velocity*** is slower and they don't need to use up as much energy fighting the current. Now in a pond, velocity is not really a problem since a pond doesn't have moving water.

One of the most common pond fish is the Three-Spined Stickleback. Larger (older) fish survive the winter best, schooling together at the pond bottom in a more or less sluggish condition.

Only half of young fish going into their first winter will survive. Some young fish will work themselves down several inches into vegetation at the bottom of the pond. This may be a little like going back to the womb for fish because male sticklebacks make nests for the female's eggs from vegetation on the pond floor.

REPTILES

Turtles

Different turtles survive winter in different ways. Just like frogs, there are ***aquatic*** turtles (those who live mostly in the water) and ***terrestrial*** turtles (those who live mostly on land).

Aquatic Turtles

Water turtles dive deep into the pond and snuggle down into some mud and leaves at the bottom. Then they let themselves get cold. Their bodies slow down so they don't need to eat. Their heart slows so it only beats once every few minutes. They stop breathing through their lungs.

Because their body is moving so slowly, they don't need much oxygen, but they do need some which they get from the water. The tough shell of the turtle doesn't allow it to absorb oxygen as readily through its skin as the frog does, but some turtles absorb needed oxygen through the skin of their throats and others absorb it through their tails. That's right! They breathe through their tails!!

Also, some turtles (like the Painted Turtle) have evolved with an altered metabolism which allows them to survive for a long time without oxygen. These turtles can stay submerged for as long as 3 months with zero blood oxygen!

Newly hatched Painted Turtles freeze solid and thaw out many times while remaining in their nests during their first winter. They are the highest known vertebrate animal that freezes.

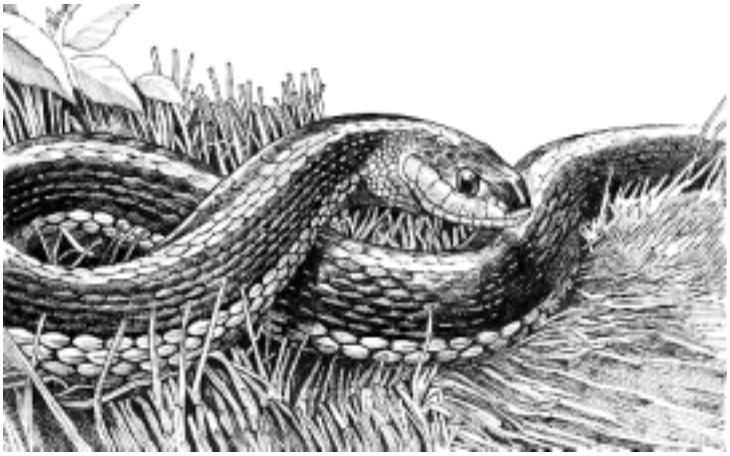
BONUS FACT: While a painted turtle can survive without oxygen for as long as 3 *months* while submerged in water, human beings cannot survive without oxygen for greater than 4 *minutes*. If a person's brain is deprived of oxygen for greater than four minutes, irreversible nerve damage commences.

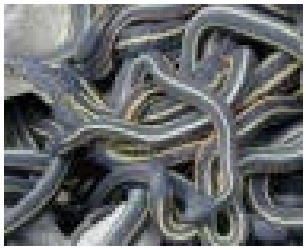
Terrestrial Turtles

Some land turtles dig as deep a burrow into the ground as they can. Others dig shallow burrows into woodland soil and leaf litter and are able to survive subfreezing temperatures for many weeks. Adult Box Turtles have some ability to survive freezing.

Snakes

Some garter snakes may travel several miles to mass by the hundreds in warm underground dens. Garter snakes are normally the last snakes to retire in the autum and the first to emerge in the spring. They are usually able to tolerate a night or two of being frozen if they're caught away from their hibernation chambers.





Name: _____ Date: _____

ACTIVITY #1

Cut out the pictures of the creatures below and sort them into two piles: Ectotherms (cold-blooded creatures) and Endotherms (warm-blooded creatures). Paste them in the appropriate box on the next page.





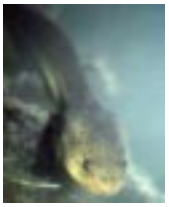












ACTIVITY #1 cont'd

ECTOTHERMS
Cold-Blooded Creatures

ENDOTHERMS
Warm-Blooded Creatures

Name: _____ Date: _____

ACTIVITY #2

The Pond in Winter: Vocabulary

Draw a line to match up the word with the correct meaning.

aquatic	A body sugar which acts like anti-freeze for some land creatures
terrestrial	Cold blooded creature
endotherm	Living on the water
torpor	A state of extreme sluggishness caused by a slow down of body functions
brummate	To become inactive or dormant
ectotherm	Beneath the snow
glucose	Living on the land
hibernate	Temporarily stopped
subnivean	Another word for hibernation
suspended	Warm blooded creature

Name: _____ Date: _____

ACTIVITY #3

Aquatic Frogs

Two kinds of frogs live in and around a pond: aquatic frogs are those who live mostly in the water, and terrestrial frogs are those who live mostly on land. Aquatic and terrestrial frogs each have quite different strategies for surviving winter's frigid temperatures.

Frogs who live mostly in the water burrow into the soil at the bottom of the pond and enter a torpid state which means that their metabolism slows down dramatically. Their hearts beat only once every few minutes. They crawl or swim, if at all, in slow motion. In this torpid state, they need very little oxygen, but the little they do need is a matter of life or death. They get it from oxygen dissolved in the water which they absorb through their skin.

1. Aquatic means
   a. lives on the land
   b. lives in or on water
   c. oxygen
   d. terrestrial

2. In this article "torpid" means
   a. oxygen dissolved in water
   b. to borrow into the soil
   c. the dramatic slow down of body functions
   d. a quick heart rate

3. In a torpid state
   a. a frog's heart beats only once every few minutes
   b. a frog crawls or swims in slow motion
   c. a frog needs very little oxygen
   d. all of the above

4. At the bottom of a frozen pond in winter, a frog gets oxygen by
   a. absorbing oxygen through its skin
   b. borrowing into the soil
   c. hopping up onto land
   d. none of the above

Name: _____ Date: _____

ACTIVITY #4

Terrestrial Frogs

Terrestrial frogs generally find shelter under grass cover or leaf litter, and many of them actually freeze solid in winter. That's right! Believe it or not, many frogs actually turn into "frog-sicles" during the winter. When ice begins to form on their skin, their body is triggered to produce massive amounts of ordinary blood sugar or glucose which acts like an antifreeze to protect their living cells.

Nearly 2/3 of a frog's body water may exist as ice, but the ice is located in non-vital areas such as the bladder, stomach cavity, beneath the skin, between organs and muscle fiber, and between cells. The glucose surrounds and packs their living cells so they don't get damaged. When frogs are frozen, their blood does not circulate and they have barely noticeable nerve activity. They have no heart beat and they do not breathe.

1. Terrestrial frogs spend winter
    a. at the bottom of the pond
    b. under grass cover or leaf litter
    c. looking for food
    d. up in a tree

2. In this article, a "frog-sicle" refers to
    a. a frozen frog
    b. glucose
    c. leaf litter
    d. a tasty snack that frogs love

3. According to this article, the glucose that the frog produces
    a. melts the snow around them
    b. causes the frogs to freeze
    c. acts like an antifreeze which protects their living cells
    d. helps their blood to circulate

4. When a frog is frozen
    a. nearly 2/3 of its body water exists as ice
    b. their blood does not circulate and they have barely noticeable nerve activity
    c. they have no heart beat and they do not breathe
    d. all of the above

Name: _____ Date: _____

ACTIVITY #5

Insects

Insects have a variety of successful strategies for surviving winter. Many insects will only survive for one year but their species survives winter because they lay eggs that will become adult insects the following spring. For example, insects like the praying mantis winter as eggs, and many species of dragonflies winter as larvae or pupa (which are stages many insects go through after they are hatched from their eggs and before they become fully formed adults.)

Other insects like ladybugs, some beetles and large wasps, hibernate in crevices and crannies under rocks, beneath leaf litter, inside the walls of homes, under eaves, in attics, under soil or burrowed in wood. Many butterflies avoid winter cold by migrating great distances to warmer climates.

Certain honeybees spend the winter in their hives. They keep warm by huddling together against the cold. The colder it gets, the closer they huddle, and each bee takes turns being on the outside of the group. To create heat, they vibrate their wing muscles. These bees consume up to 30 pounds of stored honey during the winter months (that's like 3 sacks of potatoes!)

Some insects like caterpillars and pond-skaters produce glycerol which acts like an anti-freeze and protects them from the winter cold. This doesn't prevent them from freezing, but it does decrease the formation of ice crystals in the body as the water content of their bodies is decreased and the concentration of gylcerol increased.

1. According to this article, this insect migrates to a warm place to avoid the winter cold
    a. butterfly
    b. caterpillar
    c. praying mantis
    d. lady bug

2. Larvae and pupa are
    a. eggs
    b. adult insects
    c. the stages of insect growth inbetween the egg stage and the adult stage
    d. a way to store honey

3. Honey bees
    a. spend winter in the hive
    b. huddle together to stay warm
    c. create heat in the hive by vibrating their wing muscles
    d. all of the above

4. In this article, glycerol
    a. is a source of food for insects
    b. prevents an insect from freezing
    c. acts like an antifreeze to reduce the formation of ice crystals on the insect's body
    d. is another word for hibernate

Name: _____ Date: _____

ACTIVITY #6

Turtles

Different turtles survive winter in different ways. Just like frogs, there are aquatic turtles (those who live mostly in the water) and terrestrial turtles (those who live mostly on land).

Aquatic Turtles dive deep into the pond and snuggle down into some mud and leaves at the bottom. Then they let themselves get cold. Their bodies slow down so they don't need to eat. Their heart slows so it only beats once every few minutes. They stop breathing through their lungs. Because their body is moving so slowly, they don't need much oxygen, but they do need some which they get from the water. The tough shell of the turtle doesn't allow it to absorb oxygen as readily through its skin as the frog does, but some turtles absorb needed oxygen through the skin of their throats and others absorb it through their tails.

Some aquatic turtles, like the Painted Turtle, have actually developed the ability to survive for a long time without oxygen. These turtles can stay submerged for as long as 3 months with no oxygen. Newly hatched Painted Turtles freeze solid and thaw out many times while remaining in their nexts during their first winter.

Some terrestrial turtles dig as deep a burrow into the ground as they can. Others dig shallow burrows into woodland soil and leaf litter and are able to survive subfreezing temperatures for many weeks. The adult Box Turtles, which is a terrestrial turtle, has some ability to survive freezing.

1. Aquatic turtles
    a. have some ability to survive freezing
    b. bury themselves in mud and leaves at the bottom of the pond
    c. dig deep burrows in the ground during winter to survive
    d. dig shallow burrows into woodland soil and leaf litter to survive

2. When aquatic turtles settle at the pond bottom during winter
    a. their bodies slow down so they don't need to eat
    b. they stop breathing through their lungs and absorb oxygen through their necks or tails
    c. their heart slows so it only beats once every few minutes
    d. all of the above

3. The Painted Turtle
    a. is a terrestrial turtle
    b. will die if it freezes
    c. absorbs oxygen through its shell
    d. can survive for 3 months with no oxygen

4. During winter, some terrestrial turtles like the Box Turtle
    a. have some ability to survive freezing
    b. snuggle down into mud and leaves at the bottom of the pond
    c. can survive without oxygen
    d. absorb oxygen through their tails

Name: _____ Date: _____

ACTIVITY #7

Make a chart comparing how humans prepare and act during winter (e.g. outside less, wear more clothes) vs how pond creatures respond (e.g. find places to hide, produce glucose). What are the similarities and differences?

How humans prepare and act during winter	How pond creatures prepare and act during winter

ANSWER SHEET FOR ACTIVITY #1

ECTOTHERMS
Cold-Blooded Creatures



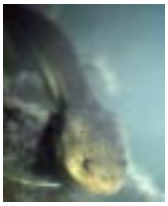












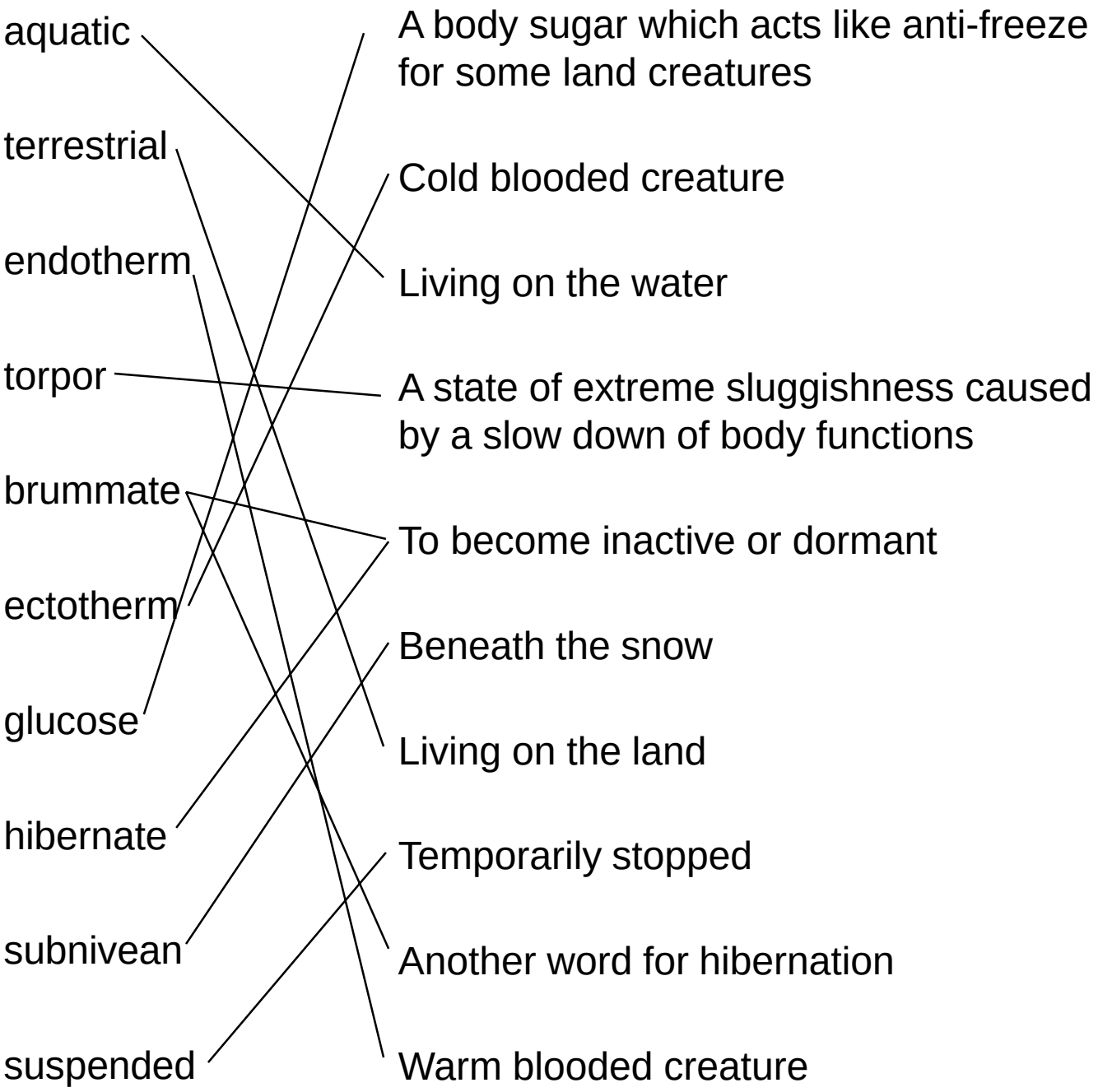
ENDOTHERMS
Warm-Blooded Creatures







ANSWER SHEET FOR ACTIVITY #2



ANSWER SHEET FOR ACTIVITIES 3-6:

ACTIVITY #3: Aquatic Frogs

1 - b

2 - c

3 - d

4 - a

ACTIVITY #4: Terrestrial Frogs

1 - b

2 - a

3 - c

4 - d

ACTIVITY #5: Insects

1 - a

2 - c

3 - d

4 - c

ACTIVITY #4: Turtles

1 - b

2 - d

3 - d

4 - a

Question #2:
Why doesn't a pond freeze all the way to the bottom?

Let's take a look at what happens to the pond itself. How much of a pond's water turns to ice?

As you know, all liquids have a boiling point and a freezing point:

- When water reaches 100°C, it turns to steam
- When it falls to 0°C, it freezes and becomes ice

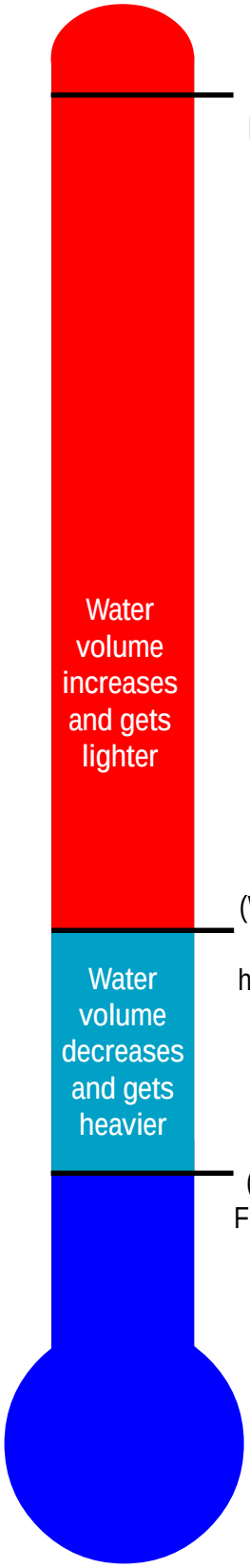
Winter temperatures often fall below 0°C. Does this mean that ponds freeze solid like giant icecubes?

As a general rule, the answer is no. Sometimes, smaller temporary ponds will freeze down to the bottom. In this case, the creatures who have used this pond as a temporary home journey to a larger pond or lake. But in most cases, only the top layer of a pond or lake will freeze. Underneath the frozen upper layer, the water remains in its liquid form, and here's why.

Most liquids expand when they are heated, but water is an exception to this rule. If water is heated above 0°C, its volume gradually decreases until it reaches 4°C. At temperatures over 4°C, water starts expanding and keeps expanding until it turns to steam at 100°C.

Therefore, at 4°C, water has its least volume -- that is, it takes up the least amount of space. If you think about this, you'll realize that it is at this point that water is at its heaviest (that is, it is at its maximum density.) This irregular expansion of water is called anomalous expansion.

Because of the anomalous expansion of water, only the top layer of a pond will freeze. Here's why:



- When the outside temperature drops to below 0°C, the upper layer or surface of the pond will start to cool
- When the surface layer falls to 4°C, the water on this upper layer is now at its heaviest and will begin to sink down, displacing the water below (i.e. the warmer, lighter water below will rise up take its place now on the pond's surface)
- Now the new top layer will be exposed to the cold outside air and it will cool. When it reaches 4°C, it too will sink down and the warmer, lighter water from underneath will rise to the surface of the pond.
- This will keep happening until, eventually, the outside air cools the top layer to below 4°C
- As we said before, when water is colder than 4°C, it decreases in volume and becomes heavier. Because all the water in the pond is now "heavy", no more sinking of the top layer will occur
- Because the sinking has stopped, the cold outside air has a chance to cool the surface even further to below 0°C at which point it freezes
- The iced over top layer acts as an insulator for the water underneath which is still at 4°C and stays at that temperature

See some Experiments on page 32 which will help you prove and understand this process

EXPERIMENTS TO SHOW THE ANOMALOUS EXPANSION OF WATER

BACKGROUND:

All material are made of of ***molecules***. Molecules are tiny particles, too small for you to see, but each molecule contains full information about the material it is part of.

These molecules can either be close to each other or further apart. How closely these molecules are bound together is called ***density***. If the molecules are very close together, we say that the material is very ***dense***.

Water can flow because the molecules of water are further apart; it is not very dense. When you heat water, the molecules go even further apart until eventually the water converts into a gas called water vapour or steam.

When you freeze water, the water molecules come closer together and increase the density (which means the water gets heavier). BUT, as we've learned, this "coming together" stops once the temperature of the water falls to 4°C. At this point, the molecules are as tight together as it is possible for them to be (and water is as heavy as it is going to get). Any attempt to push the molecules closer together (by lowering the temperature) causes strain, so the water molecules start to repel each other (i.e. they stop contracting and start moving further apart.) Once the temperature falls as low as 0°C, the water turns into ice.

At the freezing point, the molecules form a type of structure that has many air gaps which makes the ice much less dense (and therefore lighter) than liquid water. In other words, the density (heaviness) of water reaches a maximum at 4°C. As the temperature falls below 4°C, the density decreases meaning that the molecules are farther apart and the water becomes is lighter. Since water freezes below 4°C -- at 0°C -- ice is less dense (lighter) than water.

Experiment #1:

This experiment will prove that ice is lighter than water

Pour a cool glass of water and then add ice. What happens to the ice? Does it sink or float?

It floats to the surface of course. Why? Because, as we've just learned, ice is lighter than water.

Experiment #2:

This experiment will prove that water is heavier than ice

Take a one-litre container filled with ice and weigh it. Now take the same container and fill it with water. Which weighs more?

The container filled with water weighs more. Why? Because water is heavier than ice.

Experiment #3:

This experiment will prove that ice is less dense (and therefore takes up more space) than water

Fill a pastic jar with water and mark the water line with a permanent marker. Put it in the freezer overnight. When you take the container out the next day, look where the top of the ice is in relation to the line you drew. Is it higher or lower?

It's higher. In fact, if your water line was very near the top of the container when you put it in the freezer, you may even find that your container has expanded or stretched. It may even be cracked. Why? Because the ice is less dense (lighter) than water since its molecules are further apart. It needs more room than the densely packed water did.

GLOSSARY

adrenalin(e) - a hormone produced by the body which raises blood pressure and stops bleeding; blood is directed to the muscles to provide physical strength for "fight or flight" when you are scared or in danger

amphibian - Amphibians are vertebrates whose young live in water but the adults live on land. Amphibians include frogs, newts, and salamanders. The study of amphibians and reptiles is called herpetology.

anomalous - not following the usual or expected pattern

anomalous expansion - relates to fact that from 0°C to 4°C water decreases in volume; over 4°C it increases in volume until it turns to steam at 100°C

anterior - situated before or toward the front; situated near or toward the head or part most nearly corresponding to a head

aquatic - growing or living in or frequenting water

arachnid - any of a class of arthropods (mainly terrestrial or land invertebrates), including spiders, scorpions, mites, and ticks, that have a segmented body divided into two regions of which the anterior bears four pairs of legs but no antennae

arthropods - invertebrate animals (such as insects, arachnids, and crustaceans) that have a segmented body and jointed appendages

brummate - another word for ***hibernate***; Some people use the word brummate for what ***reptiles*** do. Mammals hibernate.

chrysalis - another word for ***pupa***

dense - compact or crowded together

density - the quantity of an item per unit of volume, unit of area, or unit of length

diapause - a period of physical dormancy (the state of being ***dormant***) between periods of activity; during this phase, growth, development and activities are temporarily ***suspended***; the rate of their ***metabolism*** is just high enough to keep the creature alive. This is different from ***hibernation*** during which ***vertebrates*** have minor activity and add substance to their bodies.

displacement - to move physically out of position; to take the place of

diurnation - when an animal goes into a state of ***torpor*** at night when it is cooler but is more active during the day

dormant - a suspension of activity

ectotherm - cold blooded creatures such as insects, frogs and turtles. Ectotherms cannot internally regulate their own body temperature. This means that they are only as warm or cold as the air, water or soil in which the live.

endotherm - a warm-blooded animal; having a relatively high and constant body temperature independent of the surroundings

expansion - the state of increasing the number, volume, or scope of something

fluctuating - to shift back and forth uncertainly; not ***stable***

gall - a swelling of plant tissue usually due to fungi or insect ***parasites***

glucose - a simple sugar which is an important energy source in living ***organisms***; naturally released by some land frogs as a kind of "anti-freeze"

glycerine - a colourless, sweet, ***viscous*** liquid alcohol usually obtained from fats (also called **gycerol**); naturally released by some insects as a kind of "anti-freeze"

herpetologist - a scientist that studies ***amphibians*** and ***reptiles***

hexapoda - true, six-legged insects

hibernation - to become inactive or ***dormant***

imago - an insect in its final, adult, and typically winged state

ichthyology - The study of fish.

invertebrates - animals which don't have a spinal column

larva - the immature, wingless, and often wormlike feeding form that hatches from the egg of many insects; it will change in size while passing through several ***molts***, and is finally transformed into a ***pupa*** or ***chrysalis*** from which the adult emerges. Also called a ***nymph***.

mammals - Mammals include man and all other vertebrates who feed their babies with milk from the mother's body and have skin which is more or less covered by hair. Scientists place mammals as the highest form of life.

metabolism - the chemical processes in a living organism by which food is used for tissue growth or energy production

metamorphoses - to change into a different physical form (e.g. a caterpillar into a butterfly; a tadpole into a frog)

molecules - the smallest particle of a substance that retains all the properties of the substance and is composed of one or more atoms

molt - to shed hair, feathers, shell, horns, or, in the case of insects and snakes, an outer layer

nymphs - another term for ***larva***

organism - An individual form of life, such as a plant or animal; a living thing that has (or can develop) the ability to act or function independently

ornithology - The study of birds. Scientists who study birds are ornithologists.

parasite - an ***organism*** living in, with, or on another organism

pond - A pond is a small area of still, fresh water. It is different from a river or a stream because it does not have moving water and it differs from a lake because it has a small area and is no more than around 1.8m deep. Some ponds are formed naturally, filled either by an underwater spring, or by rainwater – sometimes known as 'dewponds'; other ponds are man-made.

predator - an animal that lives by hunting and catching other animals for food

prey - animals that are killed by other animals for food

pupa - a quiet, middle stage of an insect that undergoes ***metamorphoses*** that occurs between the larva and the ***imago***. It is usually enclosed in a cocoon or protective covering, and undergoes internal changes as it transforms from a larva to an imago. Also called a ***chrysalis***.

reptiles - Reptiles include snakes, lizards, crocodiles, alligators, turtles, tortoises, and dinosaurs.

stable - not changing or ***fluctuating***

subnivean - the world beneath the snow; in really cold climates, the temperature above the snow may be as much as 50° colder than in the subnivean environment (below the snow).

suspended - temporarily stopped

tadpoles - a frog or toad larva that has a rounded body with a long tail bordered by fins and external gills soon replaced by internal gills and that undergoes a metamorphosis to the adult (also called a polliwog)

terrestrial - living on the land

torpid - sluggish in functioning or acting

torpor - a state of mental and motor inactivity with partial or total insensibility; characterized by extreme sluggishness, but is not a total slow down of body functions like that which occurs during hibernation

velocity - the quickness or rapidity of motion

vertebrates - animals possessing a spinal column that includes the mammals, birds, reptiles, amphibians, and fishes

viscous - having a thick, sticky consistency between solid and liquid; having a high viscosity

vital - absolutely necessary; essential for the maintenance of life