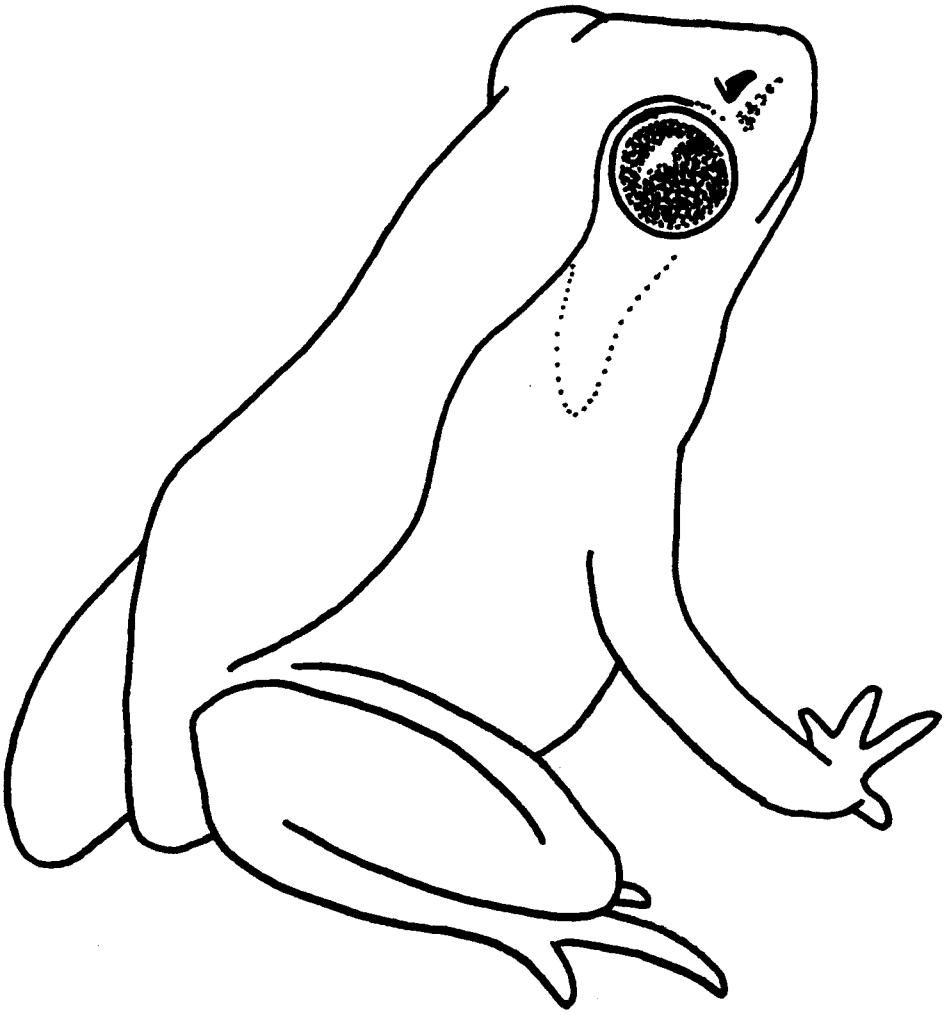
GROW - A - FROG®

TEACHER'S MANUAL



About the Author...

Cindy Jamison Gay completed her undergraduate work and obtained a Master's Degree in Environmental, Population, and Organismic Biology at the University of Colorado. For the past fifteen years, she has taught biology, environmental science, and life and physical sciences to students ranging from middle school to college undergraduates. She has taught at Kent Denver Country Day School, Eaglecrest High School in Denver's Cherry Creek School District, and the University of Colorado. For her curriculum writing and work with students, she has received numerous merit awards including the Tandy Science and Technology award and Teacher of the Year. Cindy Gay can be contacted at:

Cindy Jamison Gay
7884 S. Magnolia Way
Englewood, CO 80112
(303) 771-1016

GROW - A - FROG®
TEACHER'S MANUAL

BACKGROUND INFORMATION

What kind of animals are frogs?

Scientists generally classify all living things into five kingdoms: Monera (bacteria), Protista (single-celled creatures, both plant-like and animal-like), Fungi (mushrooms, molds, and yeasts), Plantae, and Animalia. The animal kingdom, to which frogs belong, is divided into phyla (sing., phylum). Frogs are members of the phylum Chordata (having a nerve chord). The Chordata phylum is further divided into classes, which most people commonly recognize as different groups of animals. Some of the major classes include: chondricthyes and osteicthyes (sharks and fishes), amphibia, reptilia, aves (birds) and mammals.

Frogs belong to the class amphibia (Table 1). The word *amphibian* is Greek in origin and means "two lives", referring to the metamorphosis of most of the 300,000 species of the class. There are three orders of amphibians: apodans ("legless ones" - burrowing animals that resemble earthworms), urodeles ("tailed ones" - salamanders and newts), and anurans ("tailless ones" - frogs). It is estimated that there are as many as 3800 different species of frogs.

TABLE !: Classification of a Grow-A-Frog®

CATEGORY	*GROW-A-FROG®*
Kingdom	Animalia
Phylum	Chordata
Class	Amphibia
Order	Anurans
Family	Pipidae

The word *frog* comes from English origins. In the days of King Arthur, these animals were known as *frogga;* in the time of Robin Hood, they were known as *frogge.* By the time Columbus discovered the new world, the word *frogge* had come to refer to toads and *froke* to refer to frogs. (The differences between frogs and toads will be considered later).

Amphibians were the first animals to live on land, appearing 230 million years before the dinosaurs. Amphibians are believed to have evolved from lobe-finned fishes, including a creature named *Eusthenopteron,* in the Devonian period when parts of the world were subject to periods of drought followed by heavy rains and subsequentdroughts. The oldest amphibian fossils date back 350 million years.

What do frogs look like?

In general, female frogs are larger than males, with the exception of bullfrog males which are 2-3 times larger than the females. The smallest frog in North America, less than a half inch long, is the Little Grass Frog. The largest is the bullfrog which can grow up to eight inches long. Frogs have bullet-shaped, narrow bodies with ridges down their back. Their bodies feel soft because their skeletons lack ribs.

FROG SKIN is thin and moist. Frogs absorb oxygen through their skin as well as through their lungs. However, oxygen can pass through frog skin only when it is wet. If a

frog's skin were to dry out, the frog would die. Frogs also absorb water through their skin. Thus, they do not need to drink water the way humans do.

Frog skin is quite flexible; the Narrow-mouthed Burrowing frog of South Africa can inflate its skin with air when it is frightened to appear larger to its enemies. While flexible, frog skin does not grow, and they shed their skin several times a year. The old skin splits, and the frog pushes it off with its front legs and eats it.

The color of a frog's skin helps to provide camouflage. Most frogs can slowly change their color using special dark cells in their skin which shrink and swell to make the frog lighter or darker respectively. In addition, the belly of a frog is lighter than its back. This decreases their probability of being seen by animals from below in the water, and decreases the shadow cast by the frog on land. Further, many frogs have markings on their backs which provide additional camouflage.

A FROG'S HEAD is dominated by its wide mouth. The tongue is attached to the front of the mouth and is very sticky to help catch insects. Frogs have tiny teeth on the top of their mouths, but they eat their food whole. The function of the teeth is to help hold onto the prey once it is drawn into the mouth.

The eyes are located on the top of the head, enabling the frog to see in all directions without moving its head. The eyes have two sets of eyelids; the outer, heavy lids never close, while the lower lid has a transparent membrane. This membrane can close quickly (so quickly we would never even see it!) to clean the eye and remains closed whenever the frog is underwater.

A frog's nose consists of two nostrils which open directly into the mouth. The nostrils are used to breathe and smell, and close when the frog is underwater. Although the ears are not prominent features, frogs hear quite well. The ears consist simply of a large, round membrane - the eardrum - on the outside of the head directly behind the eyes.

Male frogs have one to two pouches in their throats called vocal sacs. To croak, the male frog draws air over the vocal cords into the lungs. As the air moves out of the lungs, it produces a sound. Females usually are silent, although they are capable of making grunting noises (refer to the section on mating). Each species of frog has a distinctive sound, or call, which helps them locate potential mates in the spring.

FROG LEGS allow the frog to jump nearly ten times its body length! Two of the best jumpers for their size are the Leopard frog and the Southern Cricket Frog. The Leopard frog can jump over thirteen times its own length, a distance of over five feet; while the Southern Cricket Frog, which is less than one inch long, can jump nearly three feet! The large African Bullfrog can jump 14 feet.

A frog's front legs are short with 4 toes that help to push food into its mouth. The back legs are long with powerful muscles and 5 webbed toes. Some people eat the back legs of frogs, which they consider a delicacy. Some frogs have sticky suction cups on their toes for hanging onto tree branches. The Gray Treefrog can actually leap from branch to branch without ever touching the ground. Other frogs have pointed toes for digging in the dirt.

What - and how - do frogs eat?

Throughout the life of a frog (refer to the section on metamorphosis), its diet changes. As an egg and newly hatched larvae, the frog does not eat anything. All of its nourishment is derived from the yolk. Young tadpoles are herbivores, or vegetarians, eating phytoplankton (plant-like members of the Kingdom Protista) and algae growing on the aquatic plants. Older tadpoles may include larger aquatic plants in their diet as well.

As the tadpole changes into a froglet, its diet changes as well. Froglets are carnivorous, eating primarily insects such as grasshoppers, flies, beetles, mosquitoes, and roaches. The Dwarf Puddle frog can eat as many as 100 mosquitoes a night. In addition, froglets may also eat worms, snails, slugs and spiders. Frogs which live primarily in the water may eat small shrimp, aquatic worms, insect larvae, and tiny fishes. Large bullfrogs can eat young birds, young turtles, mice, and rats. They even eat smaller frogs and tadpoles! Some species of frogs will eat their brothers and sisters.

Frogs do not hunt for their food. Instead, they sit quietly and watch (in all directions) for an animal to come within range. When an animal does come within range, the frog uses its powerful and quick tongue, which is attached to the front of its mouth, to reach out and capture the prey and bring it back to the mouth. The frog will then use its tiny, fang-like teeth on its upper jaw and its front legs to push the food into its mouth. When a frog swallows its food, it appears as if the frog is blinking. This is because, in the swallowing process, its eyeballs press down on the roof of the mouth, forcing the food into the throat.

What kinds of animals eat frogs?

The majority of tadpoles which hatch from their eggs will not live to metamorphose into frogs. They will be eaten by one of the many predators which live with them in their aquatic environment. Some of the animals which feed upon young, vulnerable tadpoles include: birds, fish, other amphibians such as newts and salamanders, leeches, water spiders, insect larvae, water beetles, and dragonflies.

Even adult frogs have many enemies. Some of the creatures which feed upon frogs include: foxes, snakes, rats, birds, hedgehogs, badgers, stoats, weasels, owls, hawks and other raptors, herons, gulls, turtles, otters, and fish such as pike and perch.

Humans also eat the back legs of frogs. Many cultures consider frog legs to be a delicacy. Even humans who do not eat frog legs pose a threat to frog populations. Growth and development have resulted in the destruction of hundreds of acres of habitat. Chemicals introduced into the environment enter the water and harm the frog. Eggs and tadpoles are even more vulnerable than adult frogs to chemical and thermal pollutants.

How do frogs avoid their predators?

Frogs use both active and passive strategies to avoid being eaten. Active, or behavioral strategies that frogs use to avoid predators include sitting quietly (Recall that their light-colored bellies reduce shadows on land and make them harder to spot from below while in the water). When alarmed, a frog will leap away from the potential predator; jumping into the water if possible. Jumping into the water produces ripples which may confuse the predator and cause it to loose sight of the frog. Other frogs will freeze in their spot when alarmed. Some frogs even play dead by "fainting" into a state that looks like the frog is dead. Finally, most frogs are active at night when fewer predators are active and the darkness provides cover.

Passive strategies, or physical characteristics that enable frogs to protect themselves from predators include their slippery skin, which makes it difficult for predators to grasp the frog. The markings on, and coloration of the frog's back often provide camouflage. A frog's skin will also slowly lighten or darken to more closely match its surroundings. Some frogs, such as the Poison Arrow frog of South America, have poison glands in their skin, making them bad tasting so that any predator who tries to eat the frog will likely spit the frog back out. These frogs are brightly colored. The bright color serves as a warning and reminder to would be predators of the frog's bad taste. Some native Indian tribes in South America use the poison from these frog's skin to coat the tips of their arrows.

What happens to frogs in the winter? How can they survive in the desert?

Frogs are ectotherms (ecto = outside; therm = temperature), or cold-blooded, and their body temperature reflects that of their surroundings. Thus, in climates where ponds and water sources freeze in the winter, frogs are faced with two dilemmas. First, the water (and the oxygen dissolved in it) is unavailable for absorption by the skin, and secondly, the cold temperatures lower the frog's body temperature, slowing the chemical reactions inside its body. Frogs solve these problems by hibernating in a manner similar to a bear. As the temperatures drop, frogs burrow under the rocks and mud at the bottom of the pond. The frogs enter into a deep sleep-like state, and remain in hibernation until the temperatures rise again in the spring. The frogs dig out from under the mud and return to the place they were born to mate.

Frogs who live in dry, hot climates face similar dilemmas. Water is often scarce and the high temperatures cause the frog's to loose water quickly through evaporation. These frogs also

avoid the harsh environment by entering into a deep sleep-like state called aestivation. In fact, in very dry areas, certain frogs only "wake up" when it rains. These frogs quickly emerge, mate and lay their eggs, and absorb as much moisture as they can. Their body swells up and their skin secretes a thick, slimy coat which prevents them from drying out. As the rain puddles evaporate, the frog once again burrows into the ground to aestivate until the next rainfall.

What is the difference between a frog and a toad?

There are many differences between frogs and toads. These differences are summarized in Table 2. Generally, frogs live in or near water and toads on dry land. Frogs have narrow bodies with smooth skin, while toads are plump with dry, rough and warty skin (people do not get warts from touching frogs or toads - warts are caused by viruses). Frogs have long back legs and are good jumpers, but toads have short back legs, making them poor jumpers.

TABLE 2: *Differences Between Frogs and Toads*

Characteristic	Frogs	Toads
location of body ridges	long ridges on each side of body	short ridges; bumps behind eyes
ear membrane size	large (male's are larger than eyes)	small
body shape	narrow, arrow shaped	plump
length of leaps	long	short
hind legs	long	short
eggs	laid clumps	laid in strings
skin	smooth & moist	bumpy, thick, and dry
teeth	small, on upper jaw only	none
habitat	lives in or near water	lives on land
proximity to others	many individuals found together	individuals found far apart

How do frogs mate and reproduce?

Frogs breed in the early spring after they emerge from hibernation, usually returning to the pond in which they were born. The males arrive first, calling in their specific song to attract females to the pond. As the males await the arrival of the females, they develop thick black horny pads on their thumbs. These pads are used to grasp the females fat, slippery body.

Frog mating takes place in large groups at night, without the benefit of any courtship rituals. Each male grabs the nearest female, climbs on her back, and stays clasped to her for hours or even days. This clasped position is known as amplexus and takes place in the water while the female swims vigorously to keep her head above water. The female releases her eggs, and, simultaneously, the male releases his sperm to fertilize the eggs. The female grunts as the eggs are released, and the male releases his grasp. As soon as the male has released her, the female leaves, while the male remains to look for another female, to continue breeding.

Males are often observed fighting over females, especially at the close of the mating season. Occasionally, a female is drowned when several males climb upon her back. Males will even sometimes inadvertently grasp another male. Grasped males emit a special warning chirp which serves as a release call, revealing their sex.

A pair of frogs will lay several thousand eggs. Each egg is as small as a period on this page (.). The eggs have no shell, but they are surrounded by a jelly-like substance. Frog eggs are laid in clumps called frog spawn. The large and slimy clumps provide some protection for the developing egg as the egg mass is too large for many animals to eat, and the jelly coating around the egg has an unpleasant taste. Individual eggs are dark on top and light on the bottom, providing camouflage when viewed from both above and below the water's surface. While some frog spawns are attached to underwater stones or plants, most float near the surface of the water, absorbing the sun's warmth.

Not all frogs lay their eggs in water. In very wet climates, some species lay their eggs on wet, mossy ground, or in small puddles of water on the surface of large leaves. Other frogs lay their eggs in nesting burrows made from mud. African Tree frogs use their back legs to make a

nest of foam, whipped from a clear sticky liquid similar to egg whites. The outside of the foam nest hardens like meringue, keeping the eggs moist inside.

Male Midwife Toads attach their eggs to their back legs and carry them for a month and then deposit them in a pond to hatch. The Surinam Toad deposits its eggs under a pouch of skin in the female's back, where they remain until they have undergone metamorphosis. Perhaps the oddest breeding behavior is that of the Australian frog. The female of this species swallows her fertilized eggs and, two months later, the baby frogs will hop out of the mother's mouth!

Frog Development and Metamorphosis

Soon after the frog egg is laid and fertilized, the single cell divides many times and becomes an embryo. The embryo gets all of its nourishment from the yolk of the egg. Its cells continue to divide rapidly, and soon the egg is a tadpole.

As the tadpole grows, it will undergo a process called metamorphosis. The word *metamorphosis* is derived from the Greek, meaning change in form or transformation. Many other animals in addition to frogs undergo metamorphosis, including: sea stars, crabs, lobsters, and many insects such as grasshoppers, dragonflies, flies, mosquitoes, butterflies, moths, and honeybees. The process of metamorphosis is controlled by the hormone thyroxin which is produced by the thyroid and pituitary glands. The timeline of the metamorphic process described below is generalized and may be shorter or longer depending upon temperature, as well as food and moisture availability. In dry climates, the entire metamorphic process may take as little as three days. In cold climates, or where food is scarce, the process may take much longer. The average time for a Grow-A-Frog to metamorphose is three to four weeks.

A TADPOLE is composed of a head, body, tail, and external feathery gills that absorb oxygen from the water. The young tadpole will break out of the jelly coating in three days to three weeks, depending upon the species and the external environmental conditions. Once out of the jelly coating, the tadpole remains close by, clinging to the mass with suckers on its head. The tadpole continues to gain its nourishment from the yolk remaining inside its body. The tadpole's tail is a storage reservoir for fat and, if bitten off by a predator, can regenerate.

AFTER A WEEK or so, the tadpole has grown bigger, and its mouth has become hard with tiny teeth on top, allowing it to consume its vegetarian diet of algae growing on aquatic plants. The gills shrink and are covered with a flap of skin.

AFTER A MONTH, the tadpole's external gills have been replaced by new, internal gills located in the gill chamber within the tadpole's body. At the base of the tail, bulges which will develop into hind legs are visible.

AFTER TWO MONTHS, the tadpoles are large enough to eat aquatic plants as well as algae. Their gills have been replaced by lungs, so they must swim to the surface regularly to obtain oxygen from the air. The tadpole now has hind legs and bulges appear behind the head which will develop into front legs. The tail becomes smaller as the tadpole begins to reabsorb the tail tissue and use it for additional nutrition.

AFTER THREE MONTHS, the small tail of the tadpole will eventually disappear and the tadpole can now be called a froglet. The froglet now has a wide mouth with no lips, enabling it to begin to eat a carnivorous diet of small insects, worms, and even other tadpoles. The froglet will now venture out onto land in search of food. The frog will continue to grow for two to three years. Most frogs will breed after three years, although bullfrogs do not breed for five years.

Frogs in History and Language

One of the earliest written references to frogs is found in the Bible. A plague of frogs was cast upon Egypt in the days of Moses. From that time forward, frogs have had a poor reputation in history. Frogs have been associated with witchcraft and magic, and used to cast spells as well as cure ills. Evil witches regularly turned their victims into frogs and toads. In the *Frog Prince*, the handsome prince must remain a frog until the princess can overcome her revulsion at the sight of the frog long enough to offer him a kiss.

In some cultures, frogs were given god-like powers. In both ancient Roman and several Native American cultures, killing a frog would cause the frog god to send rains.

The word *frog* has many meanings in language in addition to its reference to the amphibian. A florist's frog is a piece of metal or plastic with perforations or spikes used to hold flowers in place in a vase. A violinist uses a frog, or metal nut, at the end of her bow to tighten the bow strings. A frog may be found on railroad tracks where two tracks cross. Small sprinkler heads called frogs provide a fountain of water from the backyard garden hose. A loop attached to a belt to hold a weapon or tool is called a frog, as is the ornamental braided button and loop used to fasten the front of a garment.

Plants may be inflicted with frog-eye, a leaf disease characterized by concentric rings around the diseased spot. Frog spit is an algae that forms slimy masses on quiet water. Horses sport frogs - the triangular elastic horny pad in the middle of the sole of the horse's foot. Frogmen are people equipped with fins, face masks and an air supply for extended periods of swimming underwater. Swimmers use a frog kick while swimming the breast stroke. And, finally, when a person is hoarse, they are said to have a frog in their throat.

Addition sources of frogs in literature, as well as nonfiction references may be found in the bibliography at the end of this manual.

LESSON PLANS

Lessons using live animals as the content focus may be considered either noninvasive or invasive to the animal. Noninvasive lessons (in which the animal is not affected by lesson manipulations) include paper and pencil activities, simulations, and observations of the living animal in its control - or normal, nonexperimental state.

Invasive lessons involve experiments directly affecting the environment of the frog , or the frog itself. Invasive experiments can be as simple as changing the color or ambient temperature of the animal's background environment. They can also be as complex as detailed anatomical/physiological studies involving the sacrifice of the animal. When conducting invasive experiments on live animals, the instructor should weigh carefully the benefits of conducting such an experiment (i.e., the learning experience) versus the stress or even sacrifice of the animal. Alternative noninvasive - or less invasive - learning tools such as computer simulations, models, and alternative experiments should also be considered. Ethical and biodiversity issues should be carefully balanced with the benefits of scientific animal research. Additionally, a student's potential aversion to handling and working with animals - specifically nonmammals should be considered.

The following noninvasive lesson plans are intended as a starting point for using frogs as a learning tool in the classroom. The lessons that follow may be adapted and modified for the age and ability of students within the class. The lessons are interdisciplinary and may be used individually or as a unit. Further, the lessons are structured to provide students opportunities for learning using multiple intelligences (incorporating the ideas of Gardner and others).

Lesson plans marked with an asterisk (*) use handouts which are included following the lesson descriptions. Following the lesson plans and handouts is a bibliography of fictional literature and picture books featuring frogs as well as nonfiction reference materials suitable for readers at a variety of levels.

LESSON 1: *Sharing the Background Information with Students*

Content material covering general characteristics and behaviors of frogs, as well as metamorphosis can be covered in a traditional lecture/notes format, using the following lessons as reinforcement, assessments, or extensions of the materials presented. However, using an inquiry approach, allowing students to discover for themselves the characteristics of frogs and the order of events in the metamorphic process will result in greater student involvement and retention.

Students can make daily observations of the tadpoles, recording their information in a "naturalists handbook" - a special section in a notebook, or several blank pages stapled together - including the metamorphosis timeline used in Lesson 2. As students make discoveries, the teacher can reinforce their learning with additional information and facts. For a more directed approach, each day could have a specific goal; for example, one day's objective could be to observe the frog/tadpole's head, noting location of eyes, ears, mouth, etc. When the frog is fed, observations about feeding behaviors can be recorded (i.e. the frog is more likely to eat a piece of food falling near its head than one lying on the bottom of the aquarium, or the use of the front legs in the feeding process).

Before providing any factual information about tadpoles and frogs, conduct a class survey soliciting the student's knowledge of frogs, whether factual or anecdotal. This list can be written on a large sheet of paper and saved until the end of the unit. At the end of the unit, the list can be reviewed and information marked as factual or anecdotal. Older students can draw a frog and, below the drawing, list as many facts as they can about frogs. On the back of the page, students can list as many "famous" frogs as they can, such as frogs in books and movies.

Each day's lesson could begin with a "Strange - but - True" frog fact (from the background information section) to catch the student's imagination and provide a focus for the lesson. In addition, a display of books featuring frogs could be displayed in the classroom, or read to the class. Students could each select a book featuring frogs and complete a book report.

LESSON 2: *Metamorphosis Timeline*

=use these four options individually or in combination=

Option A: Create a timeline border across a wall of the classroom. Use continuous feed computer paper or half width butcher paper as the base of the timeline. Divide the strip into equal sections representing days. Add construction paper labels to mark significant events, such as limb bud formation, disappearance of tail, etc. Students can make drawings of the tadpole at each stage, and drawings can be added to the timeline.

Option B:* Students maintain their own timeline of metamorphosis. To the timeline grid, students note dates, events in the metamorphic process, and general observations of the tadpole. When used in conjunction with Option A above, the class timeline can be used as a model for the student timelines.

Option C:* Working in teams or individually, students cut out the picture blocks of a tadpole in various stages of metamorphosis and glue them in proper order on a piece of construction paper. Alternatively, the teacher can give individuals or groups envelopes with the picture blocks already cut apart. When such envelopes are given to groups, cooperative learning strategies may be employed. For example, each student in the group may receive one or more pieces which they may (or may not) show the other group members. The group must then put the pictures in the correct order without any verbal communication. This option could be used as an assessment tool to evaluate student's learning of the processes of frog metamorphosis.

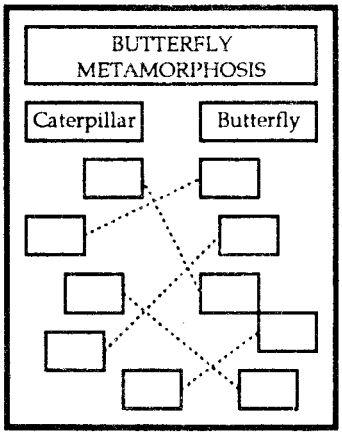
Option D:* Using the worksheet enclosed, students compare each pair of tadpoles/frogs. The youngest tadpole/frog should be circled and/or the oldest tadpole/frog underlined. Students may then color the animals. This option, too, could be used as an assessment tool to evaluate student's learning of the processes of frog metamorphosis.

LESSON 3: *Metamorphosis in Other Animals, Geology, and Toys*

Option A: After understanding metamorphosis in frogs, metamorphosis in other animals may be compared and contrasted. Information gathering and presentation of metamorphosis in other animals can span the spectrum from completely teacher-driven to independent student research. Individuals or groups could be assigned different animals to research. Appropriate materials previously acquired and assembled allows the teacher to monitor the research process. Marine animals which undergo metamorphosis include sea stars, crabs and lobsters. Nearly all insects undergo metamorphosis. Some insects for which research materials are readily available include: grasshoppers, dragonflies, house flies, mosquitoes, butterflies, moths, and honeybees.

Option B: Alternatively, one organism, such as butterflies, could be chosen to compare and contrast the processes of metamorphosis. Both students and teacher can collect pictures of various butterflies and their caterpillars and mount them on a bulletin board. Yarn can be used to connect the caterpillar to its adult form (Figure 1).

FIGURE 1: *Butterfly Metamorphosis Bulletin Board*



Option C: Metamorphosis also occurs in the geologic processes forming metamorphic rocks. For example, the sedimentary rock, limestone, under great heat and pressure will metamorphose into marble. Shale can metamorphose into slate, gneiss (pronounced nice) from granite, and quartz sandstone into quartzite. If samples of these rocks are obtained, student examination with hand lenses can produce interesting comparisons and discussions. This could be an introductory activity into further lessons on the rock cycle and geology.

Option D: Many toys on the market today are designed to undergo metamorphosis - or "morph" into other objects. Students could bring in toys or other examples of objects which metamorphose into other objects. Students could present their objects (in the spirit of "Show-and-Tell"), or the teacher may choose to collect toys labeled with students' names and exhibit them on display in a secure area of the room. Consider working with the school media specialist and interested students to display a collection of things which undergo metamorphosis in the school library, media center, or other prominent location.

Note: Many of the most popular toys on the market "morph" into aggressive weapons or military objects such as the Power Rangers and the vehicles in the comic strip, Terry and the Pirates. When using this lesson, it would be appropriate to encourage nonviolent "morphing" objects such as animal puppets, which change from one animal to another. Written communication home to parents as to the nature of the assignment and the educational value of bringing such toys to the classroom would also be beneficial.

Students may also construct or draw plans for their own "morphing" objects. The teacher could provide simple objects such as milk cartons, toilet paper tubes,

string, popsicle sticks, pipe cleaners, etc. as the starting materials for the student's morphing projects.

LESSON 4: *Frogs in Poetry and Literature*

Option A:* Using the tadpole and frog handouts enclosed, students fill in the blanks with words that begin with the appropriate letter. The words should describe their frog or tadpole.

Option B:* Students write a non-rhyming poem in the shape of a tadpole. Use the enclosed handout as a guide, or allow students to create their own shape. The poem should describe what life is like as a tadpole, or how a tadpole might feel as it undergoes metamorphosis. Ths type of poetry is called haiku when composed of three lines with five, seven and five syllables respectively, per line.

Option C: Ask students to describe the world through the eyes of a frog. Students could write their own descriptions, describe their thoughts orally in a discussion, or list them while the teacher writes the list on butcher paper. Consider, for example, that a frog's eyes are located at the top of its head, allowing the frog to see in all directions without turning its head. How would life be different if you could see in all directions at once? What would be the advantages and/or disadvantages of seeing in all directions at once?

Option D: Student groups can write and then act out a short play about a tadpole growing up. Perhaps the tadpole asks its mother why it looks so different than the adult frogs in the pond. Alternatively, students could write and illustrate a children's picture story book entitled, *Gilly Grows Up.* Older students could read their stories to younger students in the school, teaching (and thus reinforcing) their own newly acquired knowledge. Students could also read their stories to their families and bring back a note from a parent describing the family's reaction to the story.

LESSON 5: *Frog Mathematics*

Option A: Recall that frogs can jump ten times their body length. Choose ten students of approximately the same height and ask them to lay on the floor in a straight line, so that one student's head touches the next student's feet. This will provide a dramatic visual representation of how far a student could jump if he/she were a frog. To allow the ten students laying on the floor to see the distance as well, position two more students standing at each end of the line to mark the distance while the others stand to observe.

Option B: Working in groups, students take turns jumping from a standing position and measuring the distance jumped. Each student's height should also be recorded using the same units (centimeters or inches) as the jumping measurement. With this information, students can calculate their own ratio of jumping distance/ body height. Dividing jumping distance by body height will result in a decimal number less than one. A frog's ratio is 10/1.

Class data may then be collected on the chalkboard, overhead projector, or large piece of butcher paper. The class data may be copied by individual students and put into table form. A discussion of proper form to use in data table construction may be appropriate. From the class data, an average ratio can then be calculated.

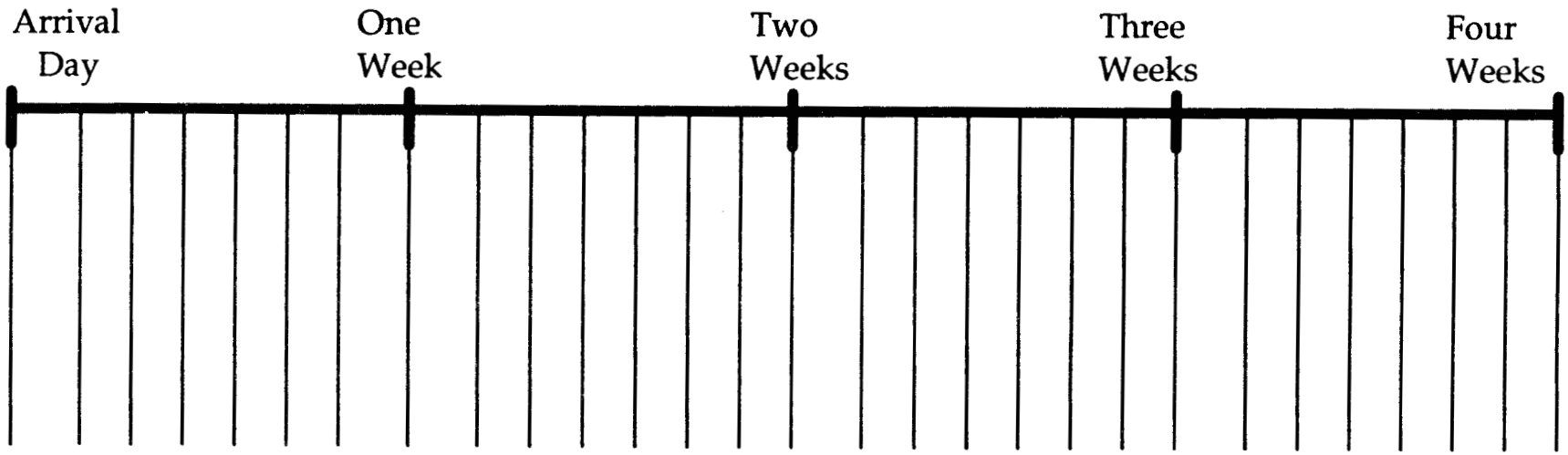
Option C: Measuring each student's height in inches or centimeters, each student can calculate how many inches(or centimeters) they could jump if they were a "human frog" (simply multiply by ten). They may then convert inches into feet or yards (or centimeters into meters). The distance, in inches (or centimeters) each student can jump from a standing position is then determined. The number of jumps the student would have to make to equal one "human frog" jump can be calculated by dividing student jumping distance into the calculated "human frog" jumping distance.

For a more visual/kinesthetic calculation, the "human frog" distance could be measured out on the floor and the student counts the number of jumps needed to cover the "human frog" distance.

Name: _____

METAMORPHOSIS: Turning Into A Frog

Directions: Note significant events on the vertical lines on the timeline below. Add more detailed observations in the spaces below.



Date: _____
Time: _____
Observations: _____
_____
_____

Date: _____
Time: _____
Observations: _____
_____
_____

Date: _____
Time: _____
Observations: _____
_____
_____

Date: _____
Time: _____
Observations: _____
_____
_____
_____

Date: _____
Time: _____
Observations: _____
_____
_____
_____

Date: _____
Time: _____
Observations: _____
_____
_____
_____

Date: _____
Time: _____
Observations: _____
_____
_____
_____

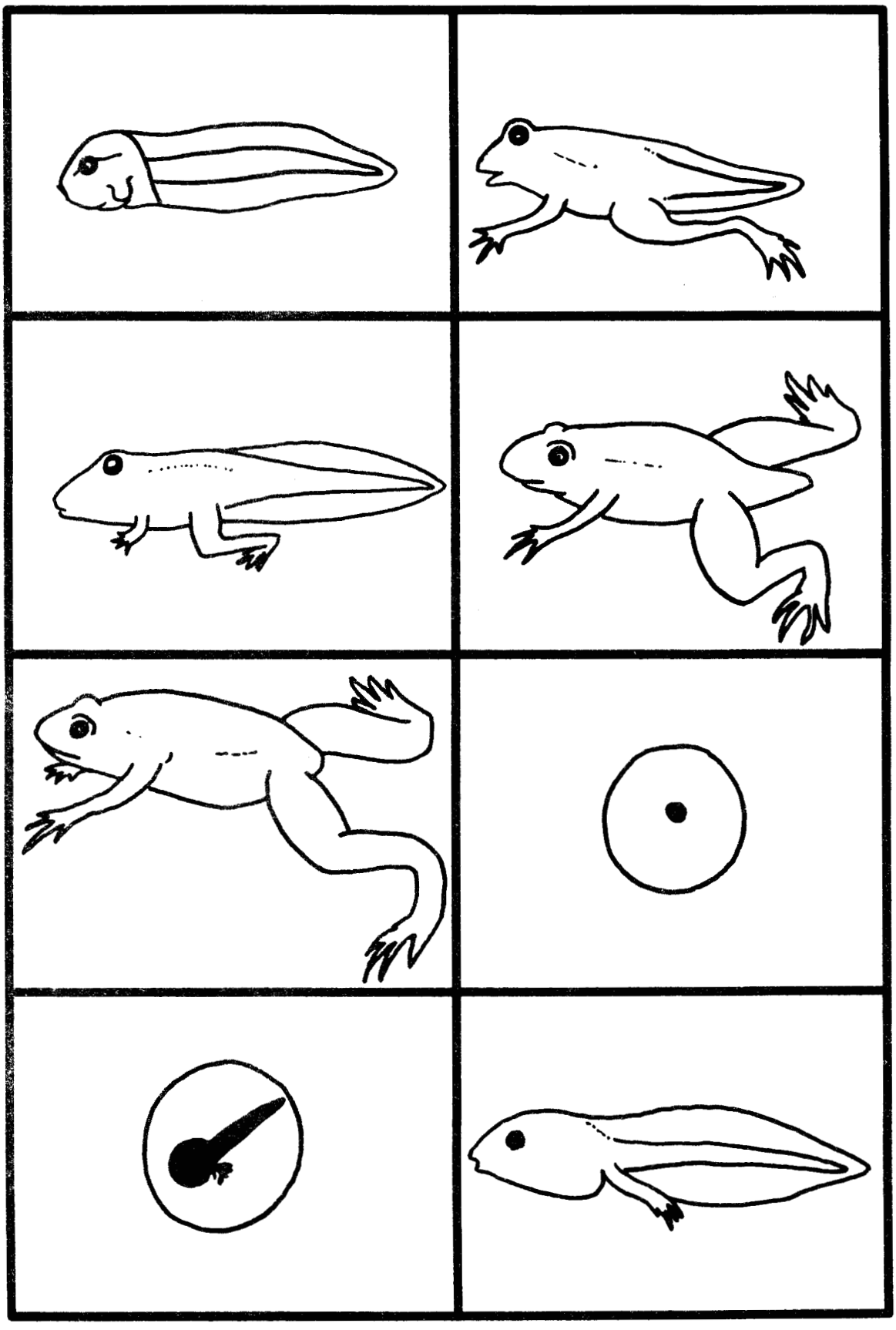
Date: _____
Time: _____
Observations: _____
_____
_____
_____

Date: _____
Time: _____
Observations: _____
_____
_____
_____

Date: _____
Time: _____
Observations: _____
_____
_____
_____

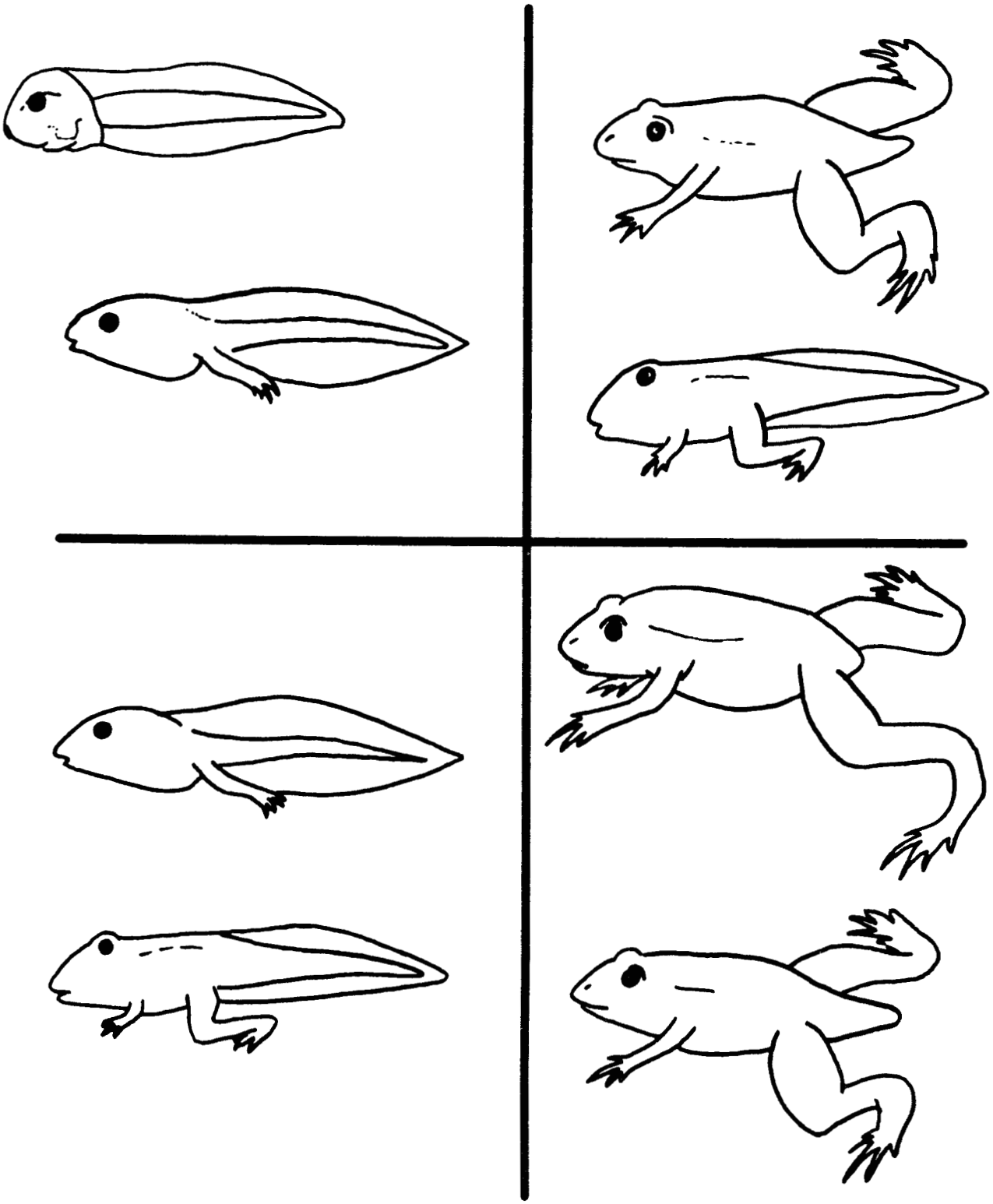
Date: _____
Time: _____
Observations: _____
_____
_____
_____

Date: _____
Time: _____
Observations: _____
_____
_____
_____

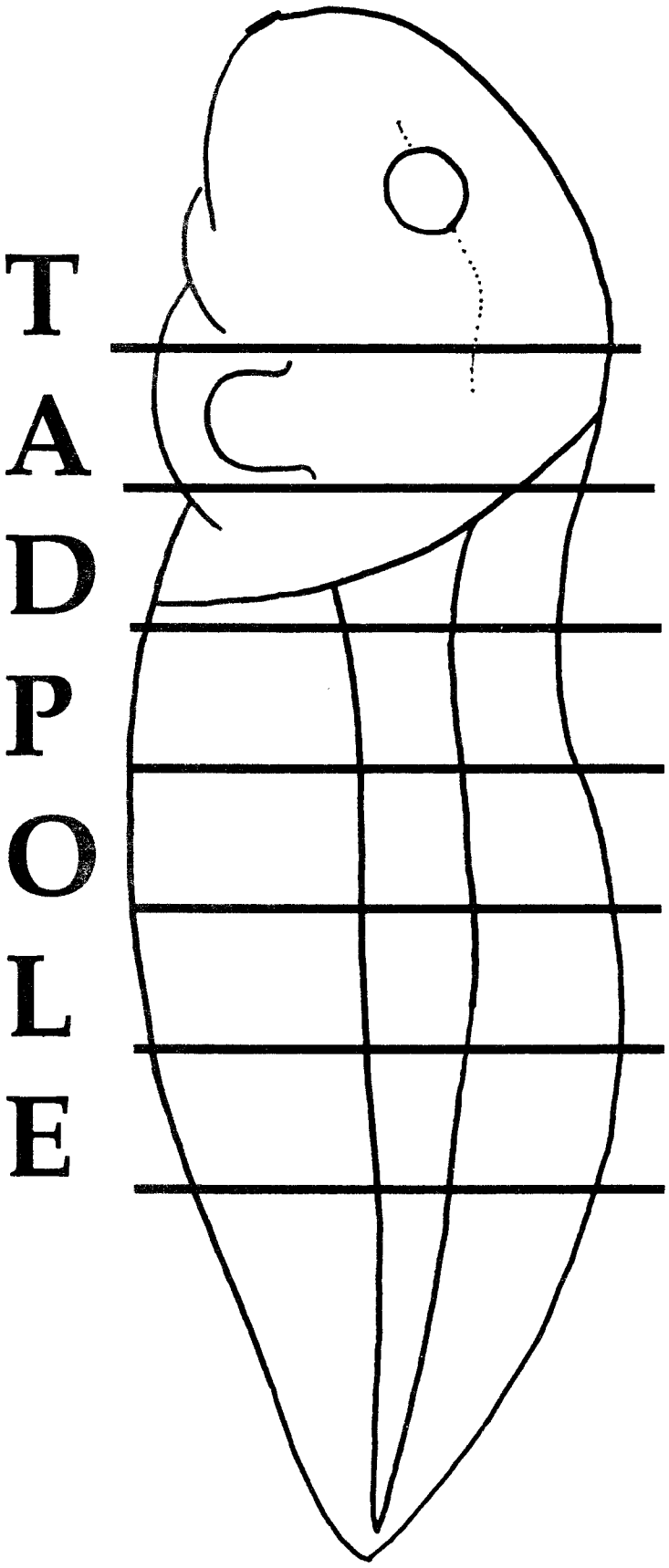


Name: _____

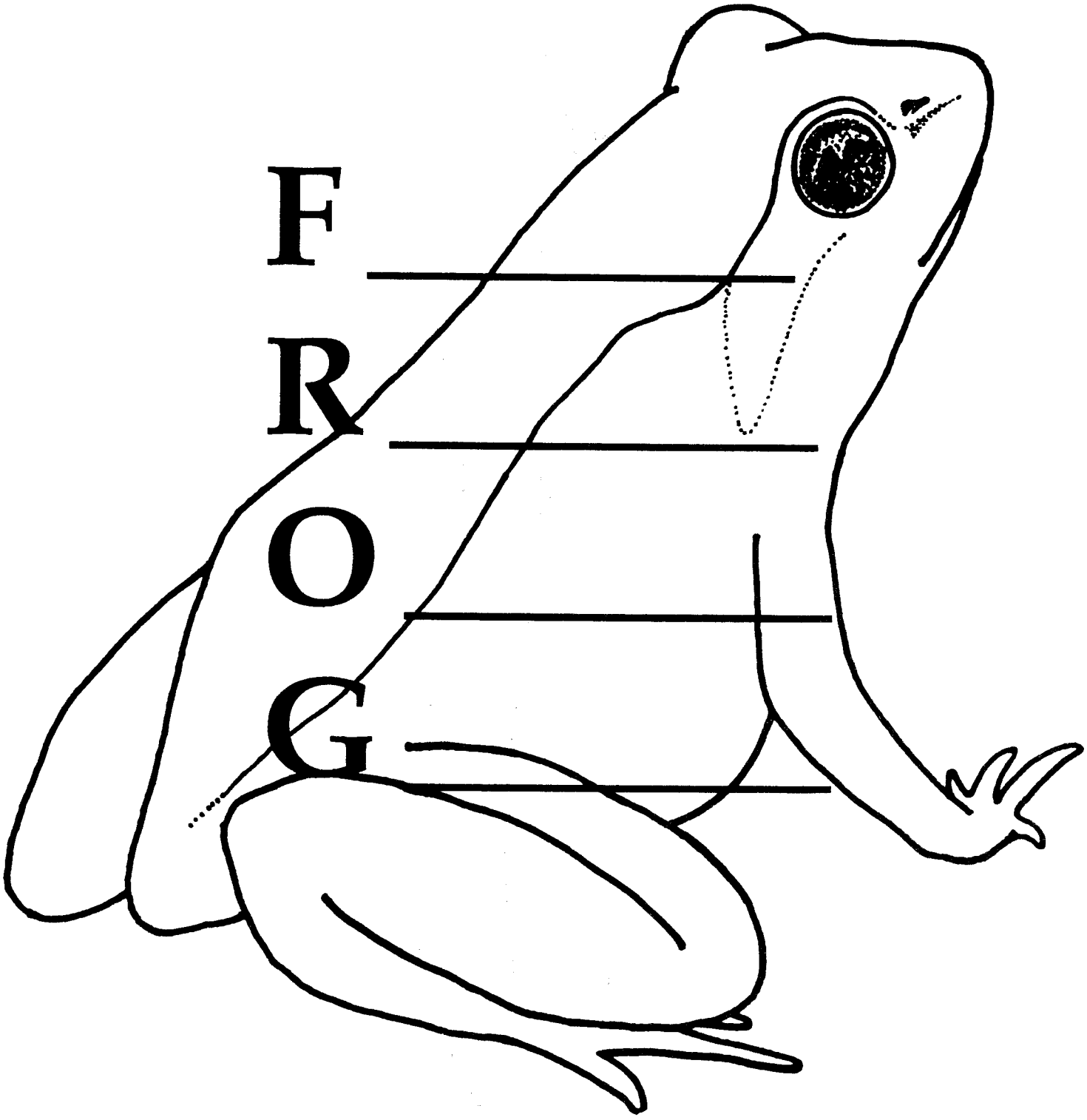
Directions: Circle the youngest frog in each pair.
Underline the oldest frog in each pair.



Name: _____

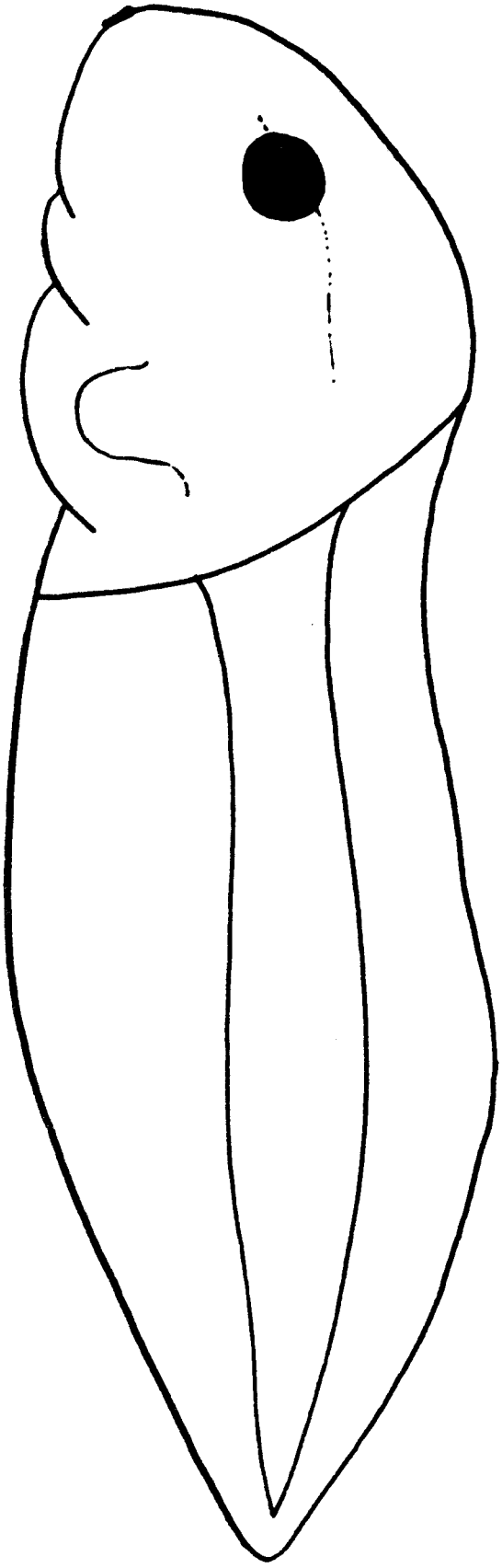


Name: _____



Name: _____

Directions: Write a poem about what it's like to be a tadpole in a pond. Make your poem fit inside the shape of the tadpole drawn below.



BIBLIOGRAPHY

Nonfiction References

Angell, Madeline. *Snakes & Frogs & Turtles & such: amphibians and reptiles of the United States.* Indianapolis: Bobbs-Merrill, 1979.

Barker, Will. *Familiar Reptiles and Amphibians of America.* New York: Harper And Row, 1964.

Cochran, Doris M. *Living Amphibians of the World.* New York: Doubleday, 1961.

Coldrey, Jennifer. *The Frog in the Pond.* Oxford Scientific Films; Animal Habitat Series. Wisconsin: Gareth Stevens Publishing, 1986.

Florian, Douglas. *Discovering Frogs.* New York: Charles Scribner's Sons, 1986.

Howell, Catherine Herbert. *Reptiles and Amphibians.* Washington, D.C.: National Geographic Society, 1993.

Johnston, Ginny. *Slippery Babies: Young Frogs, Toads and Salamanders.* New York: Morrow Junior Books, 1991.

Julivert, Angela. *The Fascinating World of Frogs and Toads.* New York: Barrons, 1993.

Lacey, Elizabeth A. *The Complete Frog.* New York: Lothrop, Lee, and Shepherd Books, 1989.

Lovett, Sarah. *Extremely Weird Frogs.* Sante Fe: J. Muir Publications, 1991.

Mattison, Christopher. *Keeping and Breeding Amphibians.* New York: Sterling Publishing., 1993.

Parker, Nancy Winslow. *Frogs, Toads, Lizards, and salamanders.* New York: Greenwillow Books, 1990.

Pfeffer, Wendy. *From Tadpole to Frog.* New York: HarperCollins, 1994.

Phillips, K. "Frogs in Trouble." *International Wildlife,* November-December, 1990.

Royston, Angela. *The Frog.* New York: Warwick Press, 1989.

Quiri, Patricia Ryon. *Metamorphosis.* New York: Franklin Watts, Inc., 1991.

Sheehan, Angela. *The Frog.* New York: Warwick Press, 1976.

Silverstein, Alvin. *Metamorphosis: the Magic Change.* New York: Atheneum, 1971.

Simon, Hilda. *Frogs and Toads of the World.* Philadelphia: Lippincott, 1975.

Wiessinger, John R. *Fish, Frogs and Snakes -- right before your eyes.* New Jersey: Enslow Publishers, 1989.

Wright, A.H. and A.A. Wright. *Handbook of Frogs and Toads of the United States and Canada, 3rd ed.* New York: Comstock, 1949.

Sound Recordings of Frog and Toad Calls

Bogert, Charles M. *Sounds of North American Frogs: the Biological Significance of Voice in Frogs.* New York: Folkways Records. (12" LP record; 92 calls of 50 species of frogs and toads; accompanied by a profusely illustrated essay on the subject.)

Kellog, Peter Paul and Arthur A. Allen. *Voices of the Night.* Boston: Houghton Mifflin for Cornell Laboratory of Ornithology in the Sounds of Nature series. (12" LP record; calls of 34 kinds of toads and frogs of eastern North America.)

Fiction featuring Frogs and Toads *(for additional sources, refer to the children's literature reference manual: From A to Zoo)*

Æsop. *The Hare and the Frogs.*

Back, Christine. *Tadpole and Frog.*

Canfield, Jane White. *The Frog Prince.*

Chenery, Janet. *The Toad Hunt.*

Dauer, Rosamond. *Bullfrog Builds A House, Bullfrog Grows Up.*

Duke, Kate. *Seven Froggies Went to School.*

Flack, Marjorie. *Tim Tadpole and the Great Bullfrog.*

Gordon, Margaret. *Frogs' Holiday.*

Graham, Amanda. *Picasso, the Green Tree Frog.*
Hamanalea. *Screen of Frogs.*
Hawes, Judy. *Spring Peepers.*
Why Frogs are Wet.
Hellard, Susan. *Froggie Goes A-Courting.*
Hirschi. *Hungry Little Frog.*
Hoban, Russell. *Jim Frog.*
Hogan, Paula Z. *The Frog.*
Kalan, Robert. *Jump, Frog, Jump.*
Karlin, Nurit. *The Blue Frog.*
Kellogg, Steven. *The Mysterious Tadpole.*
Kumin, Maxine. *Eggs of Things.*
Lane, Margaret. *The Frog.*
Lobel, Arnold. *Days with Frog and Toad.*
Frog and Toad All Year.
Frog and Toad are Friends.
The Frog and Toad Pop-up Book.
Frog and Toad Together.
London. *Let's Go Froggy!*
Maris, Ron. *Better Move On, Frog!*
Mayer, Mercer. *A Boy, a Dog, and a Frog.*
Frog Goes to Dinner.
Frog on His Own.
Frog, Where are You?
One Frog Too Many.
Newton, Patricia. *The Frog Who Drank the Waters of the World.*
Oppenheim. *Show-and-Tell Frog.*
Parker. *Working Frog.*
Partridge, Jenny. *Hopfellow.*
Pendery, Rosemary. *A Home for Hopper.*
Potter, Beatrix. *The Tale of Mr. Jeremy Fisher.*
Priceman. *Friend or Frog?*
Pursell, Margaret. *Sprig the Tree Frog.*
Rockwell, Anne. *Big Boss Toad.*
Roth. *His Majesty the Frog.*
Schertle. *Little Frog's Sound.*
Scieszka. *Frog Prince, Continued.*
Seeger, Pete. *The Foolish Frog.*
Seuss, Dr. *Would You Rather be a Bullfrog?*
Smith, David. *The Frog Band and Durrington Doormouse.*
The Frog Band and the Onion Seller.
The Frog Band and the Owlnapper.
Snape. *Frog Odyssey.*
Solotareff, Grégoire. *The Ogre and the Frog King.*
Stratemeyer, Clara. *Frog Fun Tuggy.*
Thayer, Mike. *In the Middle of the Puddle.*
Tresselt, Alvin. *The Frog in the Well.*
Van Woerkom, Dorothy. *Sea Frog, City Frog.*
Velthuijs. *Frog in Winter.*
Walsh. *Hop, Jump.*
Walt Disney Productions. *Walt Disney's The Adventures of Mr. Toad.*
Watson. *Mister Toad.*
Yolen, Jane. *Commander Toad and the Big Black Hole.*