# Lab 5: Photosynthesis



**Problem:** Can evidence of the process of photosynthesis be seen?

## Goals

1. To understand the importance of photosynthesis

2. To learn the chemical formula for photosynthesis

3. To understand how the reactants form the products

4. To observe the evidence of the photosynthetic process

## Materials and Equipment

150-mL beaker
Three small vials with caps
Tweezers
Bromothymol blue solution (BTB)

## Materials Not Included

Distilled water
Three 6 cm (approx 3 inches each) pieces of Elodea (water plant found at pet stores)
Light source
Straw
Aluminum foil
Sharpie® pen

## Introduction

The energy that allows our bodies to function ultimately comes from the sun. This may surprise you because we don't directly gain energy from standing out in the sun. The path of the sun's energy to our bodies is a little more roundabout than that. We either eat the plants or eat animals that have eaten plants in order to retrieve the energy from the sun that they contain.

Green plants use the sunlight to produce sugars with the help of a chemical called chlorophyll. The process by which plants trap light energy from the sun and store it in the chemical bonds of a sugar molecule is called photosynthesis. The chemical reaction for this process is:

$$6CO_2 + 6H_2O + Energy\,(light) \rightarrow C_6H_{12}O_6 + 6O_2$$

Notice several things about this chemical equation. There must be carbon dioxide, water, and light in the presence of chlorophyll for a plant to produce sugar (glucose) and release oxygen. During the chemical reaction, hydrogen from the water combines with carbon dioxide from the air to form a simple sugar molecule called glucose. The oxygen left over from the water molecule is released into the air. What makes this process amazing is that humans breathe out, or exhale, carbon dioxide (just what the plant needs for photosynthesis) and plants give off oxygen (just what humans need to breathe).

In this experiment, bromothymol blue solution (BTB) will be used as an indicator for the presence of carbon dioxide. As carbon dioxide is absorbed into in water it forms carbonic acid. When there is no carbon dioxide present, the BTB will show a blue color. As carbon dioxide increases in the water and forms more carbonic acid, the color will change to green and then, with even more carbon dioxide, to yellow. When a plant is put into a jar with BTB and

in the presence of all the things necessary for photosynthesis to take place, the level of $CO_2$ would be high so the solution should be yellow. As photosynthesis takes place, the $CO_2$ would be used up, making the solution turn towards blue.

## Devotional

*But without faith it is impossible to please Him: for he that cometh to God must believe that He is, and that He is a rewarder of them that diligently seek Him. Hebrews 11:6*

**Principle: Faith is essential to life in Jesus Christ.**

The process of photosynthesis is essential to life on earth. Without it, plants, which are autotrophs, would not be able to manufacture their own food in the form of sugar. Humans, like so many other organisms, are heterotrophs and cannot produce their own food; their very lives depend on the sugars manufactured by plants through photosynthesis.

Just as photosynthesis is basic to life, so there is a very basic element to the Christian life, without which, no action completed, no sacrifice made, or no act of worship offered will be pleasing and acceptable to God. That crucial element to life in Christ is faith. Hebrews 11:6 tells us that "without faith it is impossible to please God, for whoever would draw near to God must believe that He exists and that He rewards those who seek him." Are you pleasing God by seeking and trusting in Jesus Christ alone?

## Procedure

***Note: Keep the water plant in the dark so that the photosynthesis process is slowed down until you start the experiment.***

1. Place 90 mL of distilled water into a 150-mL beaker. Put twenty-four drops of bromothymol blue into the beaker.

2. Record the color of the solution in the data table in the question section of this lab.

***Note: Bromothymol blue turns blue to yellow at almost a neutral (pH 7.0). It is very possible that your water could be either slightly acidic (yellow), neutral (green), or slightly basic (blue). If your water is acidic (yellow) then do procedure 3 for one minute.***

3. Use a straw to blow **slowly** into the solution. After the solution turns yellow, continue to blow through the straw for one minute. What substance does the yellow color indicate is now present in the solution? Answer question 2 in the question section of this lab.

4. Use a Sharpie® pen to label the vials #1, #2, #3.

5. In vial #1 and #2 place one 6 cm piece of Elodea plant. You may need to fold the plant to get it all into the vial.

6. Carefully fill each vial with the solution until each is completely full. Cap each vial.

7. Completely cover vial #2 with aluminum foil so that no light can enter. Leave vial #3 with nothing but the solution in it.

8. Place all three vials about two feet from a lamp or place them in sunlight.

9. Leave the plants, undisturbed, through the night. If you using a lamp, the lamp does not need to be on the whole night.

10. In the morning, use tweezers to remove the plant from vials #1 and #2. Hold all three vials up against a white background. Compare the final colors and record them in the data table.

# Lab 5

## Questions for Photosynthesis

1. What was the color of the BTB solution?

2. What color did the BTB solution turn after blowing into it with a straw?



3. Why was the third vial left with no plant?

4. Fill in the Data Table below:

| | Initial Color of the BTB solution in each vial | Final Color after overnight by the lamp | Presence of $CO_2$ (Y/N) | Evidence of the process of photosynthesis (Y/N) |
|---|---|---|---|---|
| **Vial #1** | | | | |
| **Vial #2** | | | | |
| **Vial #3** | | | | |

5. What color was the solution indicating the presence of carbon dioxide?

6. What color was the solution when no carbon dioxide was present?

7. Would less carbon dioxide be present in a vial in which photosynthesis had occurred? Why or why not?

8. What color would the solution be in a vial in which photosynthesis occurred?

9. After sitting overnight, in which, if any, of the vials did the water changed color?

10. If there was a change in color, why do you think it occurred?

# Lab 23: Dissection: Frog



**PROBLEM:** What are the external and internal features of the frog?

## Goals

1. To become acquainted with the external anatomy of the frog

2. To become acquainted with the internal anatomy of the frog

3. To locate the structures, organs and systems of the frog

4. To assess the function of structures from observing the actual anatomy of the organism

5. To learn and practice dissection technique

## Materials and Equipment

Dissection tray
Dissection kit
Preserved frog
Ruler

## Materials not Included

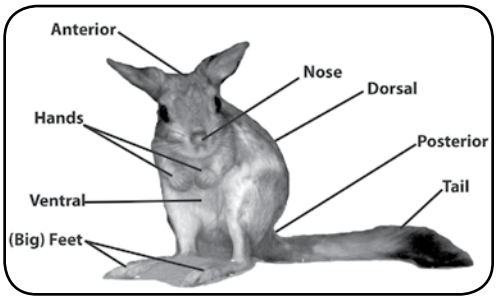
Gloves

## Introduction

Frogs are part of the phylum Chordata and are in the class Amphibia. Although the salamander might be a more "typical" amphibian, the frog is fun to dissect and a good learning experience.

## INTRODUCTION TO DISSECTION:

1. To successfully follow dissection instructions, it is essential to be familiar with the following terms:
   Dorsal—the back or upper surface of an organism
   Ventral—the stomach or lower surface of an organism
   Anterior—head end of an organism
   Posterior—tail end of an organism
2. Dissecting involves the use of sharp




cutting instruments like the scalpel and scissors. The scalpel is sharper but less easy to control than scissors. **Use care!**

3. **Important**: Whenever using scissors to cut into a specimen, make sure to keep the tip of the scissors pointed up so as not to dig down into the specimen, damaging the organs to be viewed.
4. Gloves: It is advisable to buy gloves and use them when dissecting.
5. Making and labeling drawings for dissections labs:
   a.) Make drawings as accurate as possible to what you **actually** see.
   b.) When adding labels, the label lines should be straight and should not cross each other. The line should not have arrows on them and should go directly to the object they indicate and touch it or be drawn into it. Although

the label lines may be horizontal, diagonal, or vertical, the label writing must always be horizontal. Refer to the diagram to the right.

## Devotional

*Thou shalt have not other gods before me. Thou shalt not make unto thee any graven image, or any likeness of any thing that is in heaven above, or that is in the earth beneath, or that is in the water under the earth: thou shalt not bow down thyself to them, nor serve them; for I the Lord thy God am a jealous God. Exodus 20:3-5a*

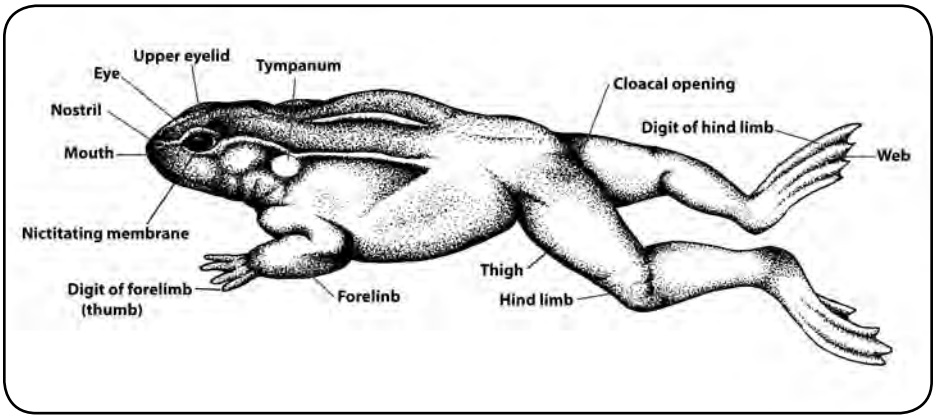
*For whosoever will save his life shall lose it, and whosoever will loses his life for My sake shall find it. Matthew 16:25*

**Principle: God will cast down our idols.**

Frogs have always been a fascination to humans; some cultures even make gods of them. The ancient Egyptians, for instance, worshipped the frog as the goddess, Heqet. But there is no god apart from Jehovah, God of the Bible. The first of the Ten Commandments is, "You shall have no other gods before me." (Exodus 20:3). God is in the business of demonstrating His Sovereignty over any other god that we may set up for ourselves. It was to be expected that, in judging and delivering His people from Egypt, God showed His power over Hequet. He caused swarms of frogs to infiltrate every "nook and cranny" of Egypt. When God ended the plague, Egypt was littered with piles of rotting, stinking frogs. (Exodus 8:14.) The very thing the Egyptians idolized became a stench and a revulsion. Be warned! If you worship false gods by choosing or esteeming anything as more important or wonderful or valuable than God, He will make these idols to become undesirable and revolting to you. God dismantles the idols in our lives because He knows that they will destroy us; and He knows that true joy and pleasure are found in Him. When you are tempted to cling to something as more pleasing or important than God, remember that God will likely make it detestable and take it from you anyway. Only in honoring and worshipping Him is real joy. "Little children, keep yourselves from idols" (I John 5:21).

## Procedure

### Part A: External Features




1. Place a frog, dorsal side up, in a dissecting pan. You will be finding and identifying distinctive structures. Refer to the diagram of the external structures as needed.

2. Locate the following structures on your own specimen and label them on the picture in question 9 of Part 1 of the questions section: **eyes, nostrils, tympanic membrane, nictitating membrane, thumb, foreleg,** and **webbed hindleg.**

3. Carefully examine the legs of the frog: Record the answers to the questions in Part 1 of the questions section.

   a. Measure the length of the foreleg and the hindleg.

   b. Measure the length of the whole frog from nose to legs stretched out

behind.

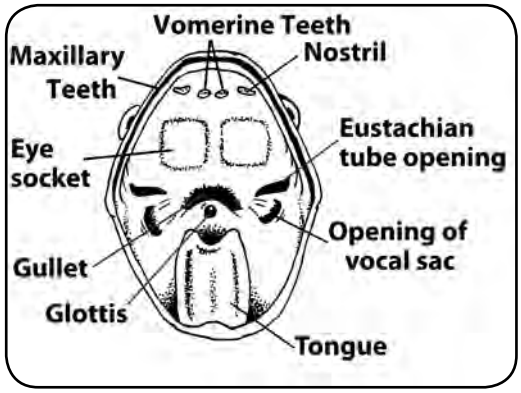
c. Count how many digits there are on the foreleg and hindleg.

d. Check to see if the forelegs are webbed. Check to see if the hindlegs are webbed.

e. Locate the thumbs on each foreleg. In males, the thumb is thickened and large.

4. Focus on the head region. Look carefully at the bulging eyes. Notice how they are situated, to enable the frog to see to the front and to the sides. Also, find the nictitating membrane — a transparent eyelid that moves from the bottom of the eye to the top. What is the purpose of this eyelid? Record your answers in Part 1.

5. The tympanic membrane is a circular membrane located below the eye. What is the purpose of this membrane?




6. Examine the mouth of the frog. To open the mouth wide, use the scissors to cut the hinge joints at both corners of the mouth. Spread the mouth open. Refer to the diagram of the mouth to find the following structures:

a. Find the tongue. Locate where it is attached to the floor of the mouth.

b. Find the glottis, gullet, esophagus, Eustachian tubes (on the sides of the upper jaw), vocal sacs (on the sides of the lower jaw), nostrils (externally and internally) and teeth.

c. The gullet is the opening into the esophagus.

d. Look to see if there are vocal sacs. If not, perhaps your specimen is a female. Only males have these openings which are used for croaking.

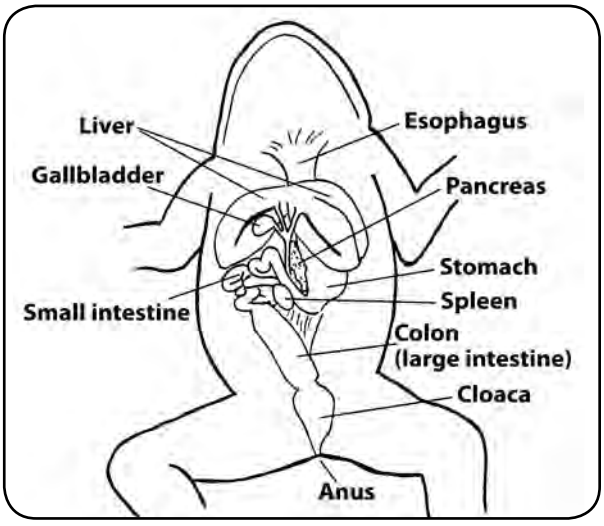
e. Locate the external and internal nostrils. Use a probe from the dissecting kit to stick through the nostrils from the outside in.

f. Find the two sets of teeth. Rub your finger along the top jaw to feel the maxillary teeth. Find the vomerine teeth located on the roof of the mouth.

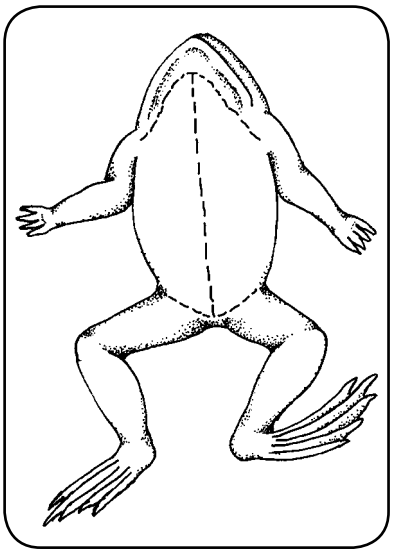
## Part B: Internal Features

***Note: Use goggles.***

7. Place the preserved frog ventral side up on the dissecting pan.




8. Refer to the dotted lines on the diagram on the next page. Using your scalpel, make a small opening through the skin slightly anterior of the anus. Insert the scissors and cut anteriorly to the tip of the lower jaw. (Make sure you are only cutting the skin.) Make additional cuts across the bottom of the forelegs and the top of the hindlegs extending the cuts to the mid-body. Cut the two flaps of skin off, exposing the muscle layer. Cut away the skin between the forelegs and the lower jaw also. Examine the skin. Look at the underside of the skin. Answer question 9 of Part 2 of the questions section.



9. To expose the body cavity, it is necessary to cut away the muscle layer. To do this, repeat the procedure for cutting away the skin. Make an incision just anterior of the anus and follow the same cutting pattern. You will find that it will be more difficult to cut along the midline up to the lower jaw because when you reach the fore legs, you must cut through the sternum (breastbone). Continue cutting, using the pattern for the skin, until you have cut away the muscle tissue, exposing the organs.
***Don't cut too deeply. It is essential to keep your scissor tips pointing upward while cutting to avoid damage to the internal organs and insuring that you are only cutting the muscle layer.***

10. If your specimen is a female, when the body cavity is exposed, you **may** see a mass of black and white eggs. You will need to remove these carefully in order to locate the other organs. To remove, lift them up with your fingers and find the place where they are attached. Work them free by pinching them off from that attachment and pulling them out. (Also note, you may still have a female specimen even though there are no black and white eggs present.)

11. Once the interior structures are exposed clearly, start to locate the structures of the different systems of the frog. Label the diagram in Part 2 of the questions section. Refer to the diagram of the internal structures of the frog if necessary.

## Digestive system:

12. When the frog ingests its food, it passes along the esophagus to the stomach. From the stomach, the food passes through the small intestines, through a short large intestines where indigestible food passes into the cloaca and then is eliminated from the body through the anus. The cloaca is a versatile organ, being the passageway for wastes, both solid and liquid, as well as the reproductive gametes, the sperm or eggs.

13. The most prominent organ you will see is a large, reddish multi-lobed organ, the liver. Gently lift up the lobes of the liver and find a small greenish sac, the gall bladder. Remove the liver by feeling under it to find its attachment and gently pinch it off there and pull it out. Count how many lobes it has, record your answer in Part 2 of the questions section.

14. The stomach, a beige organ should be visible now. Follow it anteriorly to find the esophagus and posteriorly to find the small and large intestine and the cloaca.

15. Locate the pancreas—a dark, grainy flat organ that lies between the stomach and the small intestines.

16. The spleen is located along the intestines. It is a small, dark, round organ.

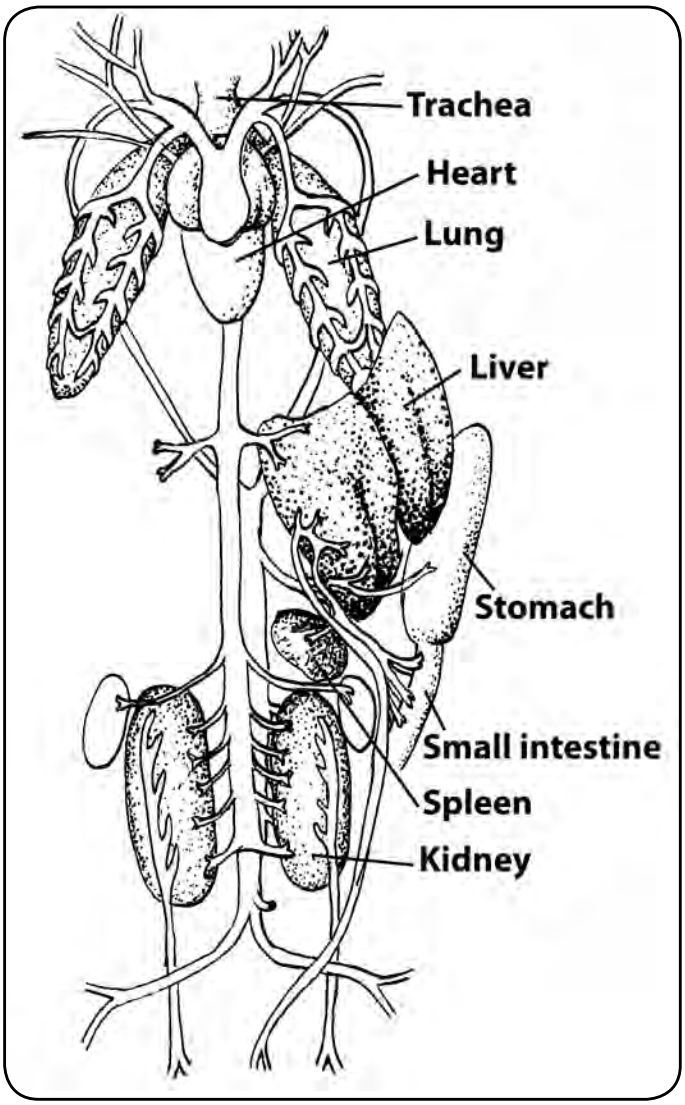
17. **Carefully**: Remove the digestive system by making a cut at the esophagus and then pulling up carefully on the stomach and along the intestines to the urinary bladder (looks like a clear, deflated balloon). Cut just anterior of the urinary bladder. If there are mesenteries (a clear, stringy-like membrane that holds body structures in place), tease them carefully away from the organs with a probe. Gently pull the organs out in one piece. *If you do not do this carefully, you could damage structures of the excretory and reproductive systems.

18. Cut open the stomach to see if there is any recognizable food left there.

19. Label the following structures on the diagram in Part B: **liver, gall bladder, stomach, esophagus, small intestines, large intestines, cloaca, pancreas, spleen,** and **anus**.

## Circulatory System:

20. The frog's three-chambered heart is the central organ of the circulatory system.




Its two atria and one ventricle pump blood through the system of veins and arteries, much like a mammalian heart. The atria are soft in texture and the ventricles are muscular.

21. Locate the heart enclosed in its special sac, called the pericardium. With a probe, tease away the pericardial sac from the heart.

## Respiratory System:

22. The frog receives oxygen in three ways, through its skin, through the lining in its mouth and through the lungs. When it does not need much oxygen, breathing through its skin is sufficient; if more oxygen is needed, it can supplement its oxygen supply through its mouth lining, and for maximum need, the frog's lungs are added.

23. The lungs, two filmy or spongy organs, lie dorsal to the heart. They are connected to the trachea which opens into the mouth cavity. Find the lungs. The trachea can be found by inserting a probe down the glottis. Label the following structure on the picture in Part 2: **lungs** and **trachea.**

## Excretory system:

24. The wastes and excess water are filtered by the kidney and then travel through the ureters to the cloaca and finally to the urinary bladder where it is stored until eliminated.

25. The kidneys are located under the reproductive structures, and are attached to the dorsal wall by the mesentery. Carefully remove the mesentery from one of the kidneys. Trace the excretory system by following the ureters, found at the posterior end of the kidneys, to the cloaca and the urinary bladder. The urinary bladder looks like a deflated transparent sac usually pressed against the body wall.

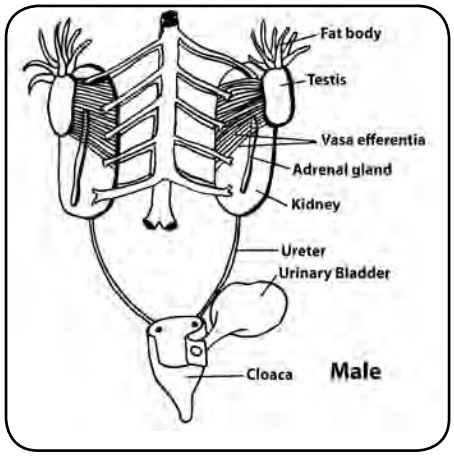
26. Label the **kidney, ureters, cloaca,** and **urinary bladder** on the picture in Part 2.

## Reproductive system:

27. In the female frog, the ovaries sit above the kidneys as a large, lobed structure. When the ovary fills with eggs, it bursts, spilling the eggs into the body cavity.

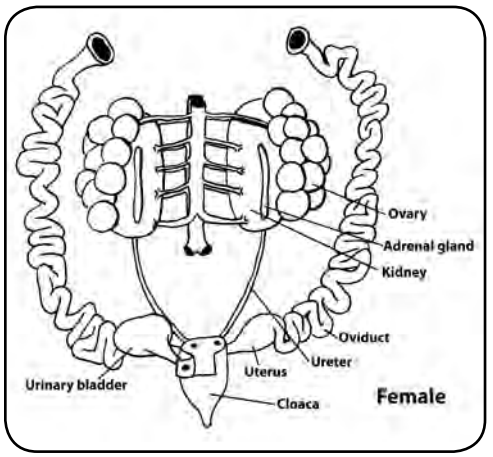
The eggs travel down the oviducts to the uterus where they are stored until expelled through the cloaca. The male frog has two oval testes. The sperm they produce travel through the kidneys to the cloaca.

28. *For a male:* Locate the mass of yellow feathery fat bodies. Attached to their




posterior end are the small yellowish oval testes. Lift one of the testes to see if you can locate the thin coiled tubules that connect it to the kidneys.

*For a female:* If there were not a mass of



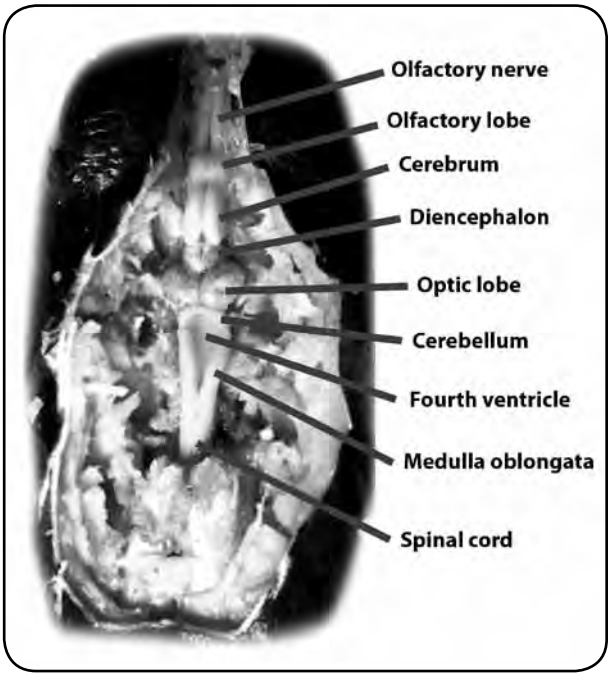

black and white eggs, the ovaries look like lumpy sacs located between the yellow fat bodies and the kidneys. The oviducts are thin and coiled leading to the uterus. If there were a mass of eggs when you first exposed the body cavity, examine the area around the yellow fat bodies for what might be left of the coiled oviducts or ovaries.

29. Carefully remove the reproductive structures.

30. Label the testes or ovary (eggs), oviducts on the picture in Part 2.

## Nervous system:

31. The frog's nervous system is made up of the central nervous system consisting of the brain and spinal cord, along with the peripheral nervous system which are all the nerves that transmit impulses to the sense organs and the muscles. The brain has five lobes: **the cerebrum, the optic lobes, the cerebellum, olfactory lobes,** and the **medulla oblongata.**




26. The brain is well protected so can be a challenge to expose. First remove the skin from the dorsal side of the head. Crack the skull (without smashing the head) and chip away the skull to reveal the brain.

# Lab 23

## Questions for Dissection: Frog



### Part 1: External Features

1. Answer the following questions:
   a. What is the length of the foreleg?_____
      Hindleg?_____

   b. How do they compare and why?

   c. What is the length of the frog's body? _____

   d. What is the ratio of the frog's hind legs to its body length? _____

   e. How many digits are on the foreleg? _____
      Hindleg?_____

   f. Are the forelegs webbed?_____
      Are the hindlegs webbed?_____

2. What is the purpose of the nictitating membrane?

3. What is the function of the tympanic membrane?

4. Why is the tongue attached where it is?

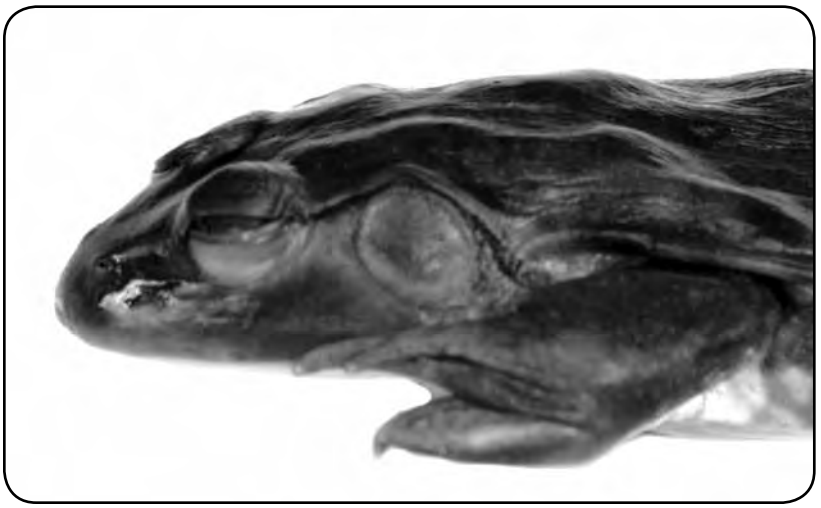
5. Why does the gullet, the opening into the esophagus, have to be so big?

6. Do female frogs croak? Why or why not?

7. What do the maxillary teeth feel like?

   What do the volmerine teeth feel like?

8. Fill in the pictures of the external structures with the appropriate labels: **eyes, nostrils, tympanic membrane, thumb, nictitating membrane, foreleg, hind leg,** and **webbed hind foot.**



## Part 2: Internal Features

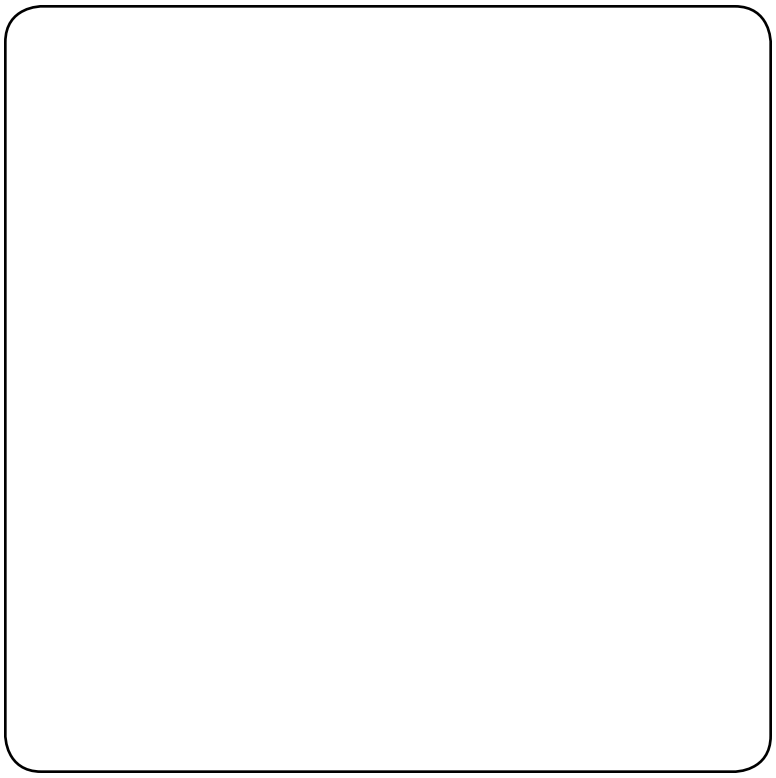
1. Is the skin thick or thin? Are there a lot of blood vessels under the skin? Why is this important?



2. How many lobes does the liver have?

3. What part does the pancreas and spleen play in digestion?

Draw the brain in the space below and label the **olfactory nerve, olfactory lobe, cerebrum, diencephlon, optic lobe, cerebellum, fourth ventricle, medulla oblongata,** and **spinal cord**.



5. Fill in these pictures of the internal structures with the appropriate labels as you can: **liver, gall bladder, stomach, esophagus, small intestines, large intestines, cloaca, pancreas, spleen, heart, lungs, kidney, urinary bladder, ovary,** and **oviduct.**