Arthropod External Dissection Lab Packet: Name:_____
Due Date:_____ Date:_____ Period:____

Crayfish External Anatomy

Introduction
Crayfish are a member of the sub-phylum *Crustacea*; these crustaceans are also known as crawdads and crawfish. There are about 150 crayfish species in North America.

Body Plan
Crayfish, like all other crustaceans, have two body segments, a cephalothorax and an abdomen. Their **carapace** shields all of their major organ systems located in their cephalothorax from predators. The **rostrum**, a pointed projection of the carapace, aids in the protection of their compound eyes. Crayfish have a variety of appendages for a variety of functions. For example, a crayfish's **chelipeds** are distinct claw-like structures that they use to defend themselves from predators.

Feeding
Crayfish are omnivores; they eat plants, animals, and decaying organisms. They have several appendages in their mouth regions that aid in their feeding process. They have three distinct mouthpart types. The **mandibles** are used for the crushing of their food. While the **maxillae with maxillary palps** and the three sets of **maxillipeds** are used by the crayfish to manipulate their food into their mouths.

Movement
Crayfish utilize a variety of their appendages in their two different forms of movement. They use their eight jointed **walking legs**, which are attached to their cephalothorax, for walking along the bottom of their aquatic ecosystem. They use their **swimmerets** and **uropods/telson** for swimming; the combination of the telson and uropods form a tail-like structure. To swim quickly they contract their muscular abdomen, propelling themselves backwards as their uropods (modified swimmerets) push the water along their ventral surface.

Respiration
Crayfish live in freshwater habitats. Most are strictly aquatic but some live in semi-aquatic environments by burrowing into the soil to get to water. Being aquatic organisms, they have a set of feathery **gills** on either side of their bodies used in respiration. These gills are attached to their walking legs and are housed under the carapace; they still come into contact with water due to the carapace only being attached to the body along the dorsal surface, allowing it to hang down freely.

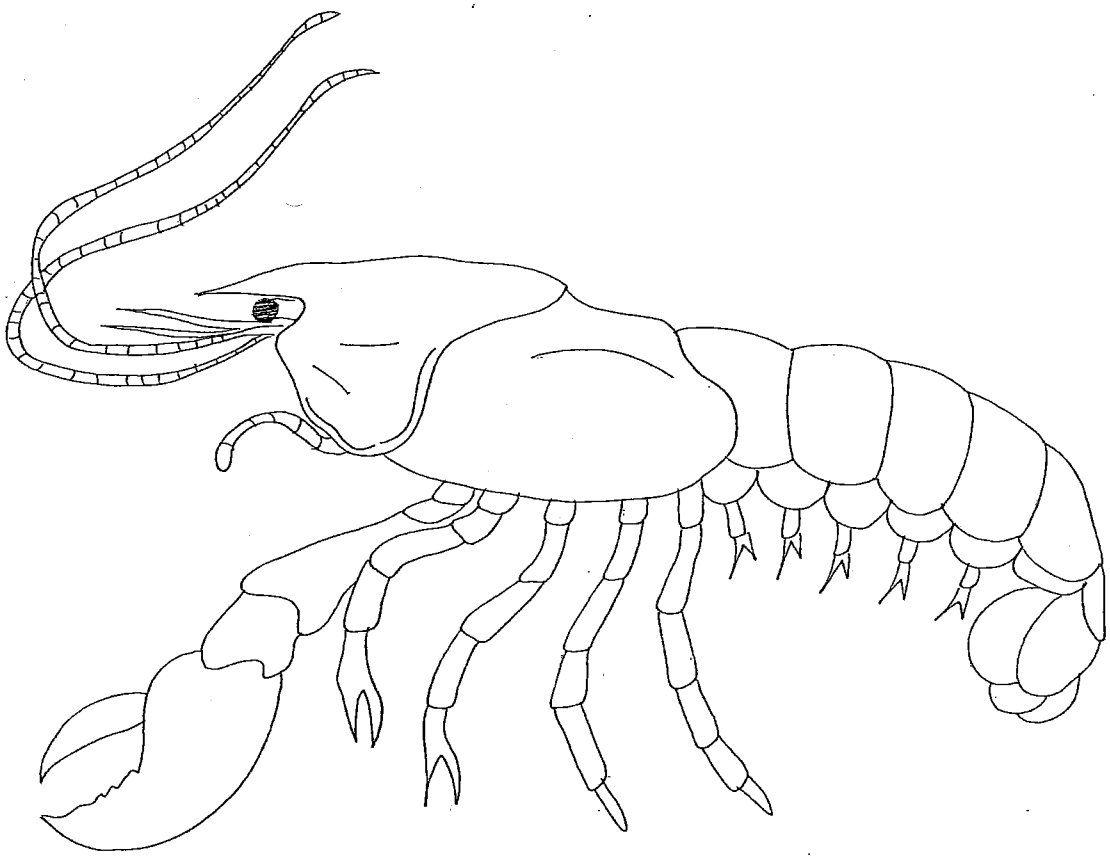
Response
Visibility may be difficult at the bottom of a stream or pond, so crayfish use their larger **antennas** and thinner **anntenules** to aid in sensing their environment. Their **compound eyes** are also helping in seeing in this type of environment.

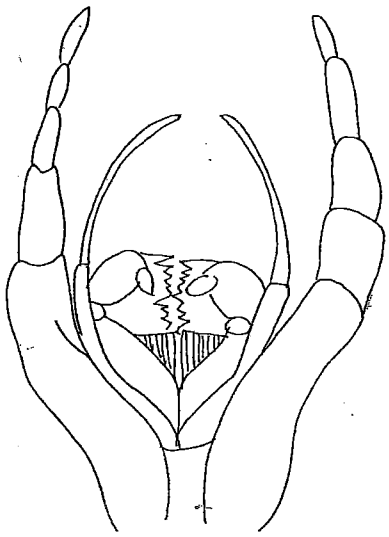
Reproduction
Crayfish have both male and female individuals. The male with internally fertilize the female by injecting his sperm into her **genital pore** through the use of his **sperm depositor**. Once the eggs are fertilized, the female will use her **swimmerets** to hold the eggs along the ventral surface of her abdomen.

Crayfish External Anatomy Coloring/Labeling Diagram

With the aid of the external dissection lab instructions, label and color the list of structures below, be sure to use different colors for each structure.

- Carapace
- Chelipeds
- Compound Eyes
- Genital Pore
- Gills
- Mandibles
- Maxillae
- Maxillipeds
- Rostrum
- Sperm Depositor
- Swimmerets
- Uropod/Telson
- Walking Legs





Arthropod External Anatomy Information Tables: Use the information provided above and in the external anatomy instruction sheet to fill in the table to keep track of important structures, their functions, and applicable body processes and/or systems.

Crayfish External Anatomy		
Structure:	**What the structure used for:**	**Body Process and/or Organ System:**
Carapace		
Rostrum		
Compound Eyes		
Mandibles		
Maxillae		
Maxillipeds		
Chelipeds		
Walking legs		
Gills		
Genital pore		
Sperm depositor		
Swimmerets		
Uropod/Telson		

Crayfish External Anatomy Questions:

1) Which side (dorsal/ventral) of the crayfish's body would be more vulnerable? Why do you think this?

2) Compare the structure and function of the crayfish's maxillipeds to that of the mandible, how do they differ? How does the function impact its structure?

3) Functionally, what is the importance having the gills attached to the crayfish's walking legs?

Grasshopper External Anatomy

Introduction
Grasshoppers are part of the class Insecta. They are terrestrial insects that experience an incomplete metamorphosis life cycle. Unlike most insects, their young are born as nymphs that appear to be miniature versions of their adult stage.

Body Plan
Grasshoppers, like other insects, have three body segments, a **head, thorax**, and an **abdomen**.

Feeding
Grasshoppers are herbivores; they utilize their complex mouth parts to grasp vegetation, cut it, and manipulate food it into their mouths. They have a **labrum** (upper lip) and a **labium** (lower lip) to protect their other delicate mouthparts. The **maxillae** are structures that have long, thin extensions called **maxillary palps** that grasp food and bring it to the **mandible**. The mandible is the deepest mouthpart that is used to masticate (cut, crush, tear, etc.) vegetation.

Movement
Grasshoppers, like other insects, have six legs. They have one pair of muscular **jumping legs** good for moving a far distance in a short amount of time. To aid in staying aloft, they use their **forewings** and **hindwings** to generate extra lift. They have two pairs of **walking legs** they employ for shorter, slower movement. Each leg consists of four parts: **coxa**, **femur**, **tibia**, and **tarsus**. The coxa is the joint that attaches the leg to the thorax. The femur and tibia provide the support for the leg, while the ridged tarsus is good for gripping.

Respiration
Grasshoppers have a complex respiratory system to move oxygen throughout their bodies. They have a series of holes, called **spiracles** that run along on both sides of their abdomen, closer to their ventral surface. These holes allow for efficient transport of gasses into and out of their bodies.

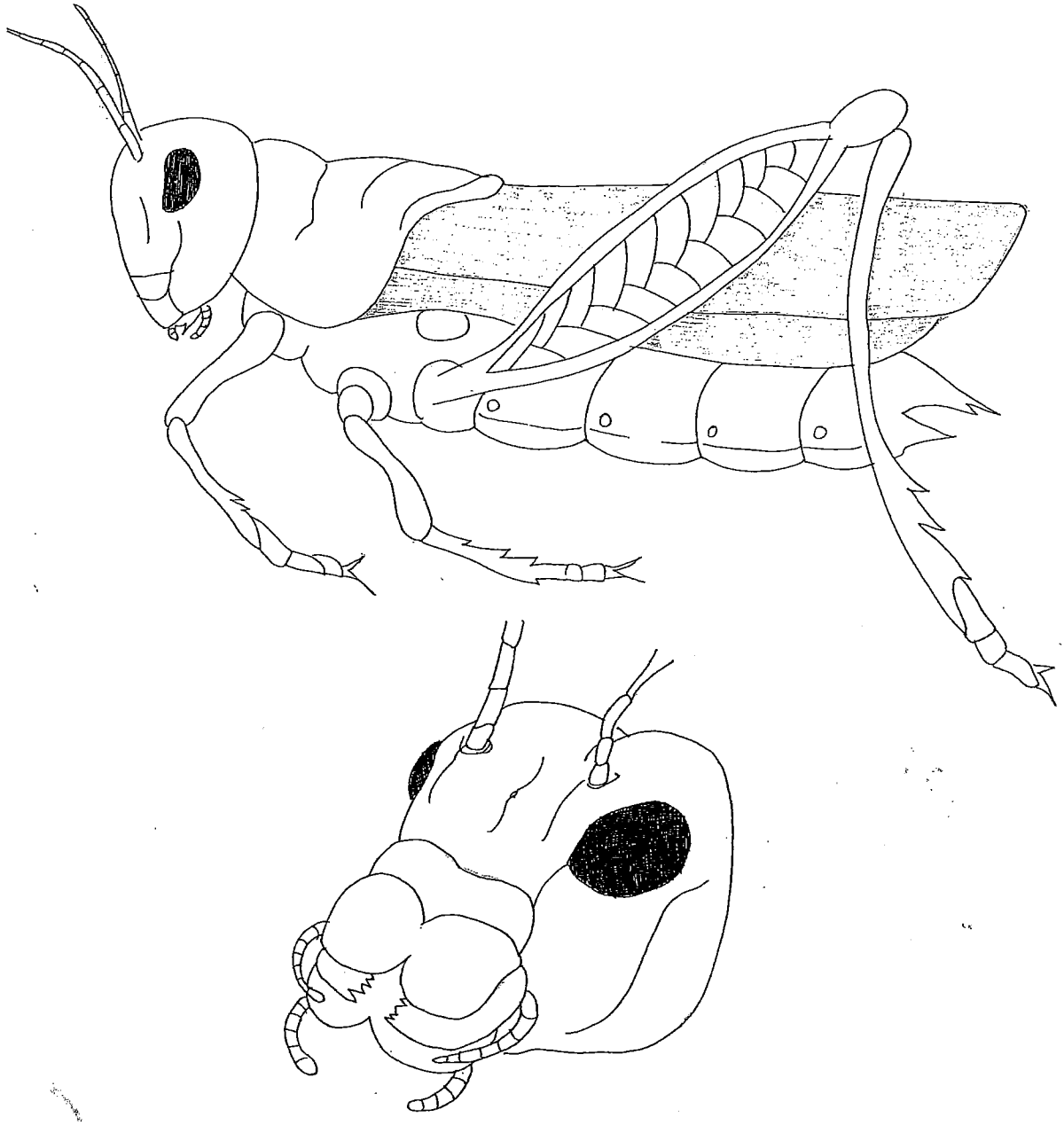
Response
Similarly to crayfish, grasshoppers have complex, **compound eyes** and **antennae** that aid in the sensing of their environments. They detect sound vibrations through the use of their **tympanic membranes** located under their forewings.

Reproduction
Grasshoppers have both male and female individuals. The male will deliver sperm to the female internally; she will lay their eggs in the topsoil through the use of her **ovipositor**.

Grasshopper External Anatomy Coloring/Labeling Diagram

With the aid of the external dissection lab instructions, label and color the list of structures below, be sure to use different colors for each structure.

- Compound Eyes
- Coxa
- Femur
- Forewings
- Hindwings
- Labium
- Mandibles
- Maxillae w/maxillary palps (AKA Palps)
- Ovipositor
- Tarsus
- Tibia
- Tympanic membrane



Grasshopper External Anatomy		
Structure:	**What the structure used for:**	**Body Function and/or Organ System:**
Compound Eyes		
Labrum		
Mandibles		
Maxillae w/maxillary palps (aka. palps)		
Labium		
Forewings		
Hind wings		
Coxa		
Femur		
Tibia		
Tarsus		
Tympanic membrane		
Ovipositor		

Crayfish vs. Grasshopper External Anatomy Questions:

1) What would be the benefit of having three body segments, seen in the grasshopper, versus the two body segments seen in the crayfish?

2) Compare the structure and function of the legs seen in crayfish to those seen in grasshoppers. How does the function impact its structure?

3) Write a summary paragraph in which you compare and contrast the external structures you identified in the crayfish and grasshopper.

Crayfish External Anatomy Dissection Check List:

You are expected to be able to identify and know the function of all of the structures on the following check-off list. Be sure to use this aid during your dissection to help hold you accountable; I will come around to complete spot-check.

- Carapace
- Rostrum
- Compound Eyes
- Mandibles
- Maxillae
- Maxillipeds
- Chelipeds
- Walking legs
- Gills
- Genital Pore
- Sperm Depositor
- Swimmerets
- Uropod/Telson

☐ ***COMPLETION OF TEACHER'S SPOT-CHECK***

Grasshopper External Anatomy Dissection Check List:

- Compound Eyes
- Labrum
- Mandibles
- Maxillae w/maxillary palps (AKA. palps)
- Labium
- Forewings
- Hindwings
- Coxa
- Femur
- Tibia
- Tarsus
- Tympanic membrane
- Ovipositor

☐ ***COMPLETION OF TEACHER'S SPOT-CHECK***

Arthropoda External Dissection Lab Instructions

Name:_____

Date:_____ Period:_____

Objective: To compare/contrast the external anatomy of two different examples of arthropods.
Identify important external structures of crayfish and grasshoppers.

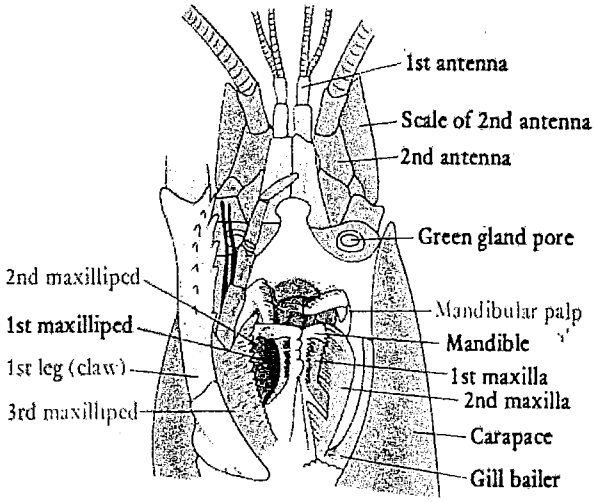
Directions: Follow the procedure below and answer the corresponding questions.

Materials:

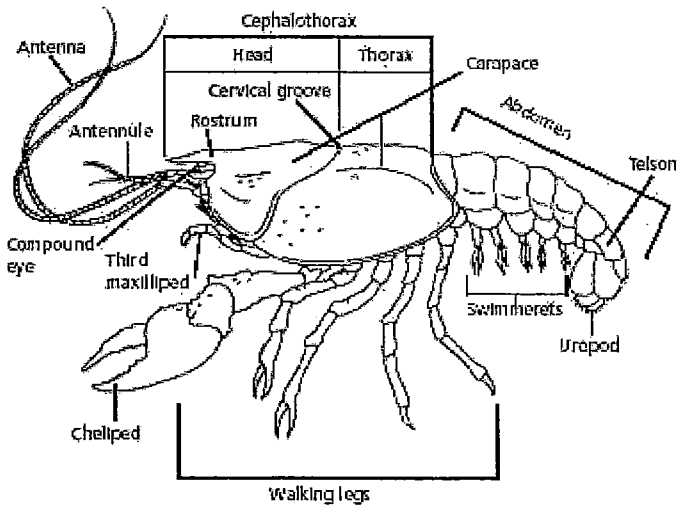
Crayfish and grasshopper specimens	Tweezers	Goggles	Blunt probe
Dissection pan	Gloves	Zipblock bag	

Crayfish External Anatomy Dissection Procedure:

1) Obtain materials and crayfish specimen
2) Place crayfish with its dorsal side up in a dissection tray. Use the diagram below to locate the **cephalothorax** and **abdomen**. The **carapace,** a chitin shield, covers the dorsal surface of the cephalothorax. On the carapace, observe an indentation, the **cervical groove** that extends across the midregion and separates the **head** and **thoracic regions.**
3) Turn the crayfish on its side and locate the **rostrum**, which is the pointed extension of the carapace at the head of the animal shown in the diagram above. Beneath the rostrum locate the two **compound eyes.** Notice that each eye is at the end of a stalk.
4) Turn the crayfish so that its ventral surface is face up. Locate the mouth. Then observe the **mandibles**, deep to the other mouthparts. Now locate the two pairs of **maxillae**.
5) On the thoracic portion of the chepalothorax observe the three pairs of pointed **maxillipeds**.
6) Next observe the largest prominent pair of appendages, the **chelipeds**, or claws. Behind the chelipeds locate the four pairs of **walking legs**, one pair on each segment.
7) Remove one of the walking legs and observe the feathery structure that is attached at the top, these are the **gills.**



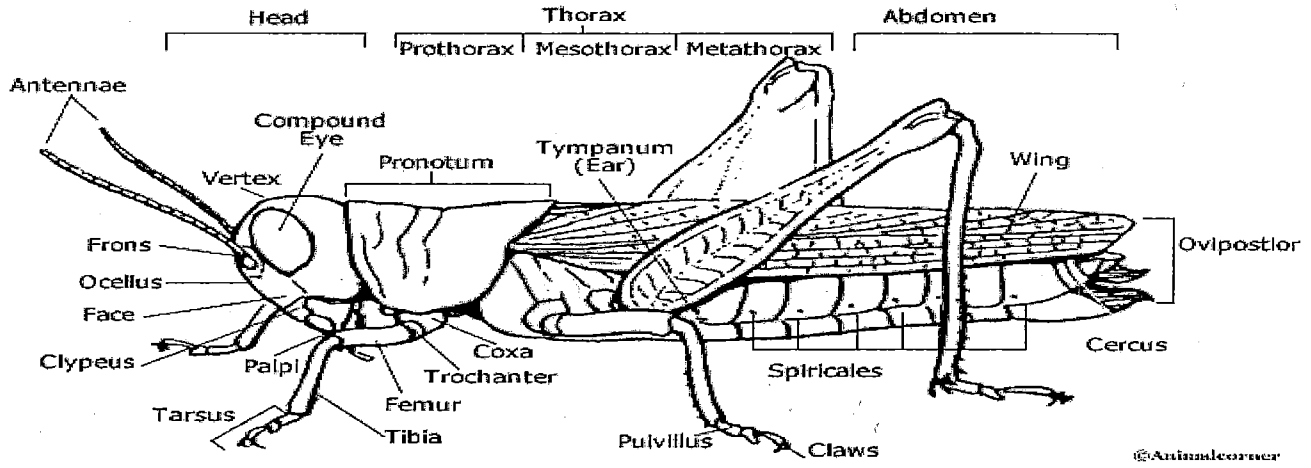
8) Now use the walking legs to determine the sex of your specimen. Locate the base segment of each pair of walking legs. The base segment is where the leg attaches to the body. Study the inside surface of the base segment of the third pair of walking legs. If you observe a raised bump/crescent-shaped slit, you have located the **genital pore of a female**. In a male, the **sperm depositors** are on the base segment of the fourth pair of walking legs. They extend up between the walking legs, looking like an extra pair of swimmerets.
9) Determine the sex of your specimen._____
10) On the abdomen, observe the six distinct segments. On each of the first five segments, observe a pair of **swimmerets.**
11) On the last abdominal segment, observe a pair of pointed appendages modified into a pair of **uropods**. In the middle of the uropods locate the triangular-shaped **telson**.

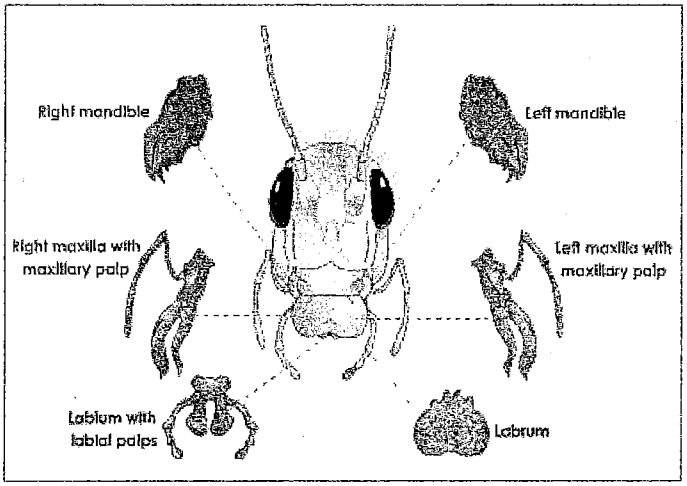


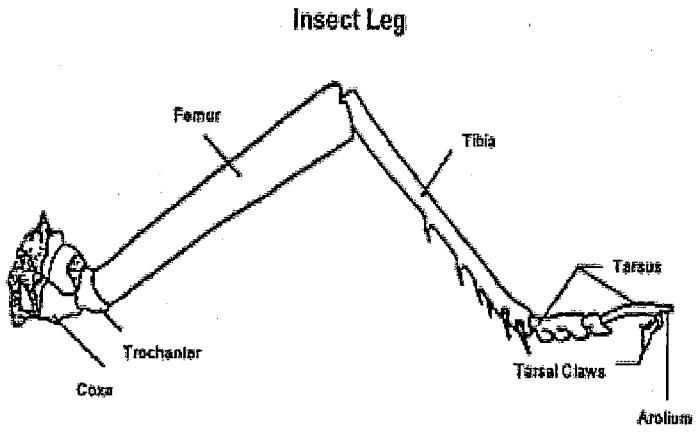
12) Label all of the bolded words on the diagrams provided for you in your lab packet; refer above.

Grasshopper External Anatomy Dissection Procedure:

1) Obtain your grasshopper specimen.
2) Observe the three regions of the body: the **head, thorax, and abdomen.**
3) Examine the head region containing the eyes, antennae, and mouthparts.
4) Locate the large **compound eyes** on either side of the head.
5) Examine the mouthparts, which are adapted for chewing on plants. Locate the **labrum**, or upper lip. Beneath the labrum are two sets of jaws called the **mandibles** and **maxillae w/maxillary palps**. The mandibles are used for cutting, tearing, and crushing food. The maxillary palps are located posterior to the mandibles and are used for cutting and holding food. Directly behind the maxillary palps is the **labium**, or lower lip.
6) Examine the three pairs of legs and two pairs of wings attached to the thorax. The first two pairs of legs are for walking and the last pair of legs is for jumping. The **forewings** have a leathery appearance and protect the **hind wings**, which are made of broad membranes with many veins.
7) Using the forceps, remove one of the walking legs. The **coxa** connects the **femur**, the thickest section of the leg, to the grasshopper's body. A slender, spiny **tibia** connects the femur to the **tarsus**, or bottom part of the leg.
8) Raise both pairs of wings, and locate the first abdominal segment.
9) Observe the **tympanic membrane**, or ear, on the first abdominal segment.
10) Observe the extreme tip of the abdomen. In males, the abdomen is rounded and turned upward. In females, the abdomen is more tapered and ends in a hard, pointed structure called the **ovipositor**. The ovipositor is used for laying eggs in the ground. Determine the sex of your specimen._____
11) Label all of the bolded words on the diagrams provided for you in your lab packet.







Arthropod Internal Dissection Lab Packet: Name:_____
Due Date:_____ Date:_____ Period:____

Crayfish Internal Anatomy

Central Nervous System:
The nervous system of the crayfish a similar to (but more complex than) that of the earthworm. The "**brain**" is a mass of nerve ganglion just in front of and above the esophagus. In addition to this, the crayfish has other ganglia located near the chelipeds and mouthparts to better coordinate their movement. Notice the very fine thread-like nerves connecting the brain to the eyes, antannae, and antennules. The brain sends electrical pulses through nerves to control the various organs and muscles, and to collect sensory information from its environment. Two nerves lead from the brain, around the esophagus, and combine to form the **ventral nerve cord** which runs to the end of the abdomen. The ventral nerve cords carry these electrical pulses throughout the body.

Cardiovascular System:
Crayfish have an open circulatory system; their **dorsal tubular heart** contains holes. This results in their blood seeping in and out of their circulatory system to other parts of their body cavity. The heart pumps the blood through the body.

Digestive System:
Crayfish are carnivorous scavengers lending to the fact that their digestive systems are relatively simple. As seen in the external anatomy, crayfish of complex mouthparts to aid in the feeding process. Upon entering the mouth, the food travels down the short **esophagus** into the **stomach**. There are two chambers of the stomach, the first is a pouch that stores the food, while the second contains teeth inside to help grind up food. They have a **digestive gland** which produces digestive enzymes which in aid in the chemical breakdown of their food. Undigested material passes into the **intestine** from the lobed stomach. The undigested material is eliminated from the **anus**.

Respiratory System:
Being aquatic organisms, crayfish have **gills** that aid in respiration. These featherlike structures are found underneath the carapace and are attached to the chelipeds and walking legs. As the crayfish move these appendages a constant flow of water moves through the carapace over the gills. This creates a constant current of water over the gills supplying oxygen and carrying away carbon dioxide and other wastes.

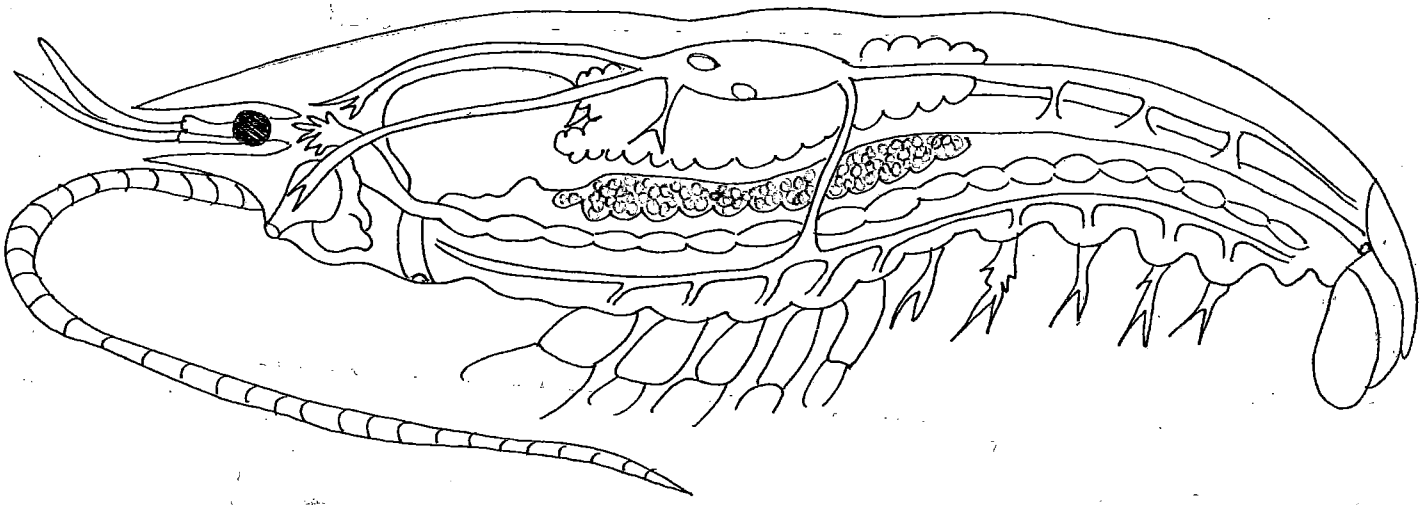
Excretory System:
The blood carries cellular wastes to the disk-like **green glands** that are located anterior to the stomach; the green glands excrete waste through pores at the base of each antenna.

Reproductive System:
Crayfish have individual sexes and carry out sexual reproduction through internal fertilization. **Testes and ovaries (gonads)**. These structures are found in similar location within the body, just ventral to the heart. They are responsible for producing either eggs ore sperm. Once fertilization occurs, the female releases her eggs from her genital pore and catches them with her swimmerets.

Crayfish Internal Anatomy Coloring/Labeling Diagram

With the aid of the external dissection lab instructions, label and color the list of structures below, be sure to use different colors for each structure.

- Anus
- Brain
- Digestive gland
- Esophagus
- Gonads (Ovaries/testes)
- Green glands
- Heart
- Intestine
- Stomach
- Ventral Nerve Cord



Arthropod Internal Anatomy Information Tables: Use the information provided above and in the internal anatomy instruction sheet to fill in the table to keep track of important structures, their functions, and applicable body processes and/or systems.

Crayfish Internal Anatomy		
Structure:	**What the structure used for:**	**Body Process and/or Organ System:**
Anus		
Brain		
Digestive Gland		
Esophagus		
Gills		
Green glands		
Heart		
Intestine		
Stomach		
Ventral Nerve Cords		

Grasshopper Internal Anatomy

Central Nervous System:
Grasshoppers and crayfish share a similar nervous system. Like the crayfish, the grasshopper's "**brain**" is a mass of nerve ganglion just in front of and above the esophagus. In addition to this, the grasshopper has other ganglia located near the jumping legs and wings in order to better coordinate their movement. The brain sends electrical pulses through nerves to control the various organs and muscles, and to collect sensory information from its environment. The **ventral nerve cord** runs from the brain through the abdomen. The ventral nerve cords carry these electrical pulses throughout the body.

Cardiovascular System:
Grasshoppers have an open circulatory system that is rather simple. They have a tubular heart connected to a major blood vessel which run along the dorsal surface of the animal. The vessels are open to the hemoplymph in which nutrients and wastes can be exchanged with the body. This system is not affiliated with the distribution of carbon dioxide and oxygen because the complex respiratory system does this on its own.

Digestive System:
Grasshoppers are herbivores, which requires a more complex digestive system to break down the plants' cell walls. From their mouth a short **esophagus** connects to the large, thin-walled **crop**. The crop is a storage area and fills most of the thoracic region. The small, muscular **gizzard** is posterior to the crop. The gizzard contains tooth-like structures for grinding food. Posterior to the gizzard, you will observe the **stomach**, or **midgut**. Eight pairs of pouches, called **gastric caeca** are attached to this structure. These pouches contain digestive enzymes that are released into the stomach to aid in chemical digestion. Posterior to the stomach, you will observe a narrowing of the digestive tract, this is the **intestine**. The intestine sends undigested food out of the body through the anus.

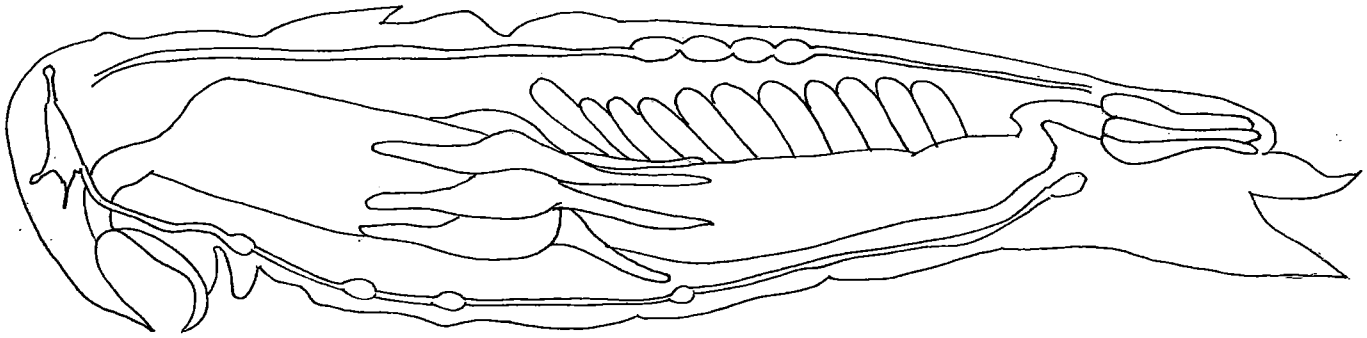
Respiratory System:
Grasshoppers have a complex respiratory system that functions independently of the circulatory system, unlike most complex animals. As discussed with its external anatomy, grasshoppers take in oxygen and release carbon dioxide through a series of small holes called spiracles that run along their thoracic and abdominal regions. Oxygen diffuses into cells directly from the atmosphere and that completes the grasshopper's process of respiration. Connected to the spiracles are a series of tracheal tubes and air sacs that deliver oxygen to all of the tissues throughout the body.

Reproductive System:
Grasshoppers have individual sexes and carry out sexual reproduction through internal fertilization. Fertilized **eggs** develop inside of the female, looking a lot like orange grains of rice. She will use her ovipositor to lay the eggs in top layer of soil. Little miniature grasshoppers, called nymphs, will hatch from these eggs.

Grasshopper Internal Anatomy Coloring/Labeling Diagram

With the aid of the external dissection lab instructions, label and color the list of structures below, be sure to use different colors for each structure.

- Brain
- Crop
- Eggs
- Esophagus
- Gastric Ceca
- Gizzard
- Heart
- Intestine
- Mouth
- Stomach (mid-gut)
- Ventral Nerve Cord



Grasshopper Internal Anatomy		
Structure:	**What the structure used for:**	**Body Process and/or Organ System:**
Brain		
Crop		
Esophagus		
Gastric Ceca		
Gizzard		
Gonads (ovaries and testes)		
Heart		
Intestine		
Stomach (mid-gut)		
Ventral Nerve Cord		

Crayfish vs. Grasshopper Internal Anatomy Conclusion Questions

1. Compare and contrast the path that food takes through the digestive system of the crayfish and the grasshopper.

2. Why might the grasshopper require a more complex digestive system than the crayfish? HINT: Think about what they eat.

3. Which structure do both crayfish and grasshopper have inside their stomach? Why is this structure necessary?

4. Explain why a grasshopper's circulatory system is so underdeveloped.

5. We didn't have you look for this, but if you were to look carefully at the ventral nerve cord in the grasshopper and the crayfish you would see several ganglia (collections of nerve cells) in addition to the brain. In the grasshopper the largest ganglion, other than the brain, is located in the most posterior part of the thorax. In the crayfish, the largest ganglion, other than the brain, is located in the anterior most part of the thorax region of the cephalothorax. Explain why, in terms of structure, these animals would require such large ganglia in these specific areas of their bodies.

Crayfish Internal Anatomy Dissection Check List:

You are expected to be able to identify and know the function of all of the structures on the following check-off list. Be sure to use this aid during your dissection to help hold you accountable; I will come around to complete a spot-check.

- Brain
- Ventral Nerve Cord
- Heart
- Esophagus
- Stomach
- Digestive Gland
- Intestine
- Gills
- Green glands
- Gonads (testes or ovaries

COMPLETION OF TEACHER'S SPOT-CHECK

Grasshopper Internal Anatomy Dissection Check List:

- Ventral nerve cord
- Esophagus
- Crop
- Gizzard
- Gastric ceca
- Stomach
- Intestine
- Eggs

COMPLETION OF TEACHER'S SPOT-CHECK

Arthropod Internal Anatomy Dissection Name:_____

Due Date:_____ Date:_____ Period:____

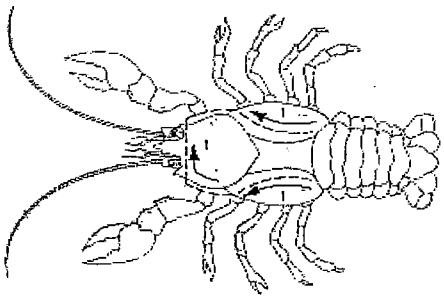
Objective: To compare/contrast the internal anatomy of two different examples of arthropods. Identify important internal structures of crayfish and grasshoppers.

Directions: Follow the procedure below and answer the corresponding questions.

Materials:

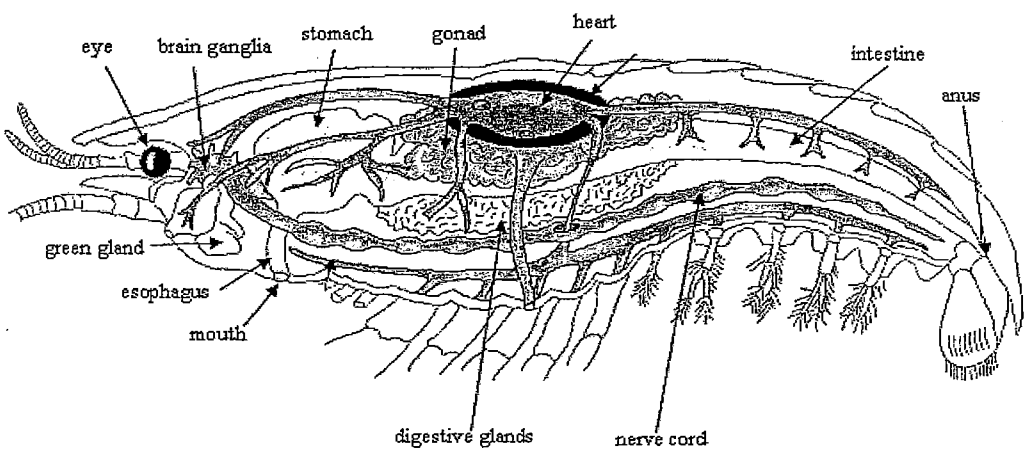
Specimens	Forceps	Blunt probe	Scissors
Dissection pan	Gloves	Zip-lock bag	Sharp probe

Crayfish Internal Anatomy Dissection Procedure



1) Obtain materials and your crayfish specimen.
2) Using one hand to hold the crayfish dorsal side up in the dissecting tray, use scissors to carefully cut through the back of the carapace as shown in the diagram to the right. Be sure to **carefully** cut just behind the eyes to best observe anterior structures.
3) Carefully lift away the carapace so as not to destroy the underlying structures.
4) Remove any remaining carapace using your scissors. You will also need to carefully remove a portion of the dorsal surface along the abdominal region to expose the **intestine** better.
5) The **gills** are easily identifiable after removing the carapace. They will look like feathery, o greyish structures just above the walking legs on each side of the animal. There will be a piece of clear exoskeleton separating them from the body cavity.
6) Move the **stomach** to one side, you can locate the short **esophagus** extending from the mouth to the two-chambered **stomach**. It is a thin-walled sac-like structure, just posterior to the eyes.
7) Carefully shift the stomach posteriorly to observe the **green glands**, disk-like structures just behind the eyes.
8) **Gently** bend the head down to better expose the **dorsal ganglia (brain),** ideally you should be able to observe white **nerve cords** extending from the brain towards the ventral surface.
9) On either side of the stomach, there is a beige-like, granular material; this makes up the **digestive gland.**
10) Just posterior to the stomach is a small, clear pouch; this is the **heart**.
11) The heart sits just dorsal and anterior to the **gonads (testes or ovaries).** Look for what appears to be eggs to distinguish ovaries.
12) Ventral to the heart and gonads, extending from the stomach is the **intestine**; it will extend through the abdomen, ending at the anus. The anus can be observed on the ventral surface of the telson.
13) Label all of the bold words on the crayfish diagram on the provided page.

The Major Systems of a Crayfish



Grasshopper Internal Dissection Procedure

1) Place your grasshopper specimen in the dissecting pan.
2) Using your scissors, remove both pairs of wings and the three pairs of legs. Be sure NOT to insert the tips of the scissors too deeply to avoid puncturing the internal organs.
3) Beginning at the tympanic membrane, use the scissors to cut along the sides of your grasshopper through the abdomen and thorax. Connect your cuts just posterior to the head on the dorsal surface.
4) Using forceps, carefully remove the entire cut section.
5) Locate the short **esophagus** that connects the mouth to the large, thin-walled **crop**.
6) Locate the small, muscular **gizzard** posterior to the crop.
7) A good way to distinguish between the crop and the gizzard is to locate the **gastric caeca,** they are orange and finger-like in structure. They separate the two different portions of the digestive system.
8) Posterior to the gizzard, you will observe the **stomach**, or **midgut**.
9) Posterior to the stomach, you will observe a narrowing of the digestive tract. This is the **intestine.**
10) Using a sharp dissection needle, gently move aside the internal organs to find the whitish **ventral nerve cord** along the ventral surface of the specimen.
11) Label all of the bolded words on the grasshopper diagram on the provided page.