Close Reading and Text Dependent Questions in Science
The Insect Empire (Diversity of Life – Grade 7)

The text selection, *The Insect Empire,* is found in
FOSS Student Resources Book, Diversity of Life, pgs. 55-59.


THE INSECT EMPIRE

How many different kinds of insects can you think of? Ten, twenty, thirty? Let's see, there are ants, butterflies, cockroaches, bees, flies...uuuh, grasshoppers, mosquitoes, crickets.

Thirty different insects sounds like a lot, but it's not. There are *millions* of different species of insects. In fact, there are more species of insects in the world than all other kinds of organisms potential, and structure, to mention a few. Structure is a good place to start.

INSECT STRUCTURES

Insects are covered head to toe with a tough, rigid, watertight **exoskeleton.** This protective outer covering is the insect's version of the suit of armor a knight might have worn during the Middle Ages. The exoskeleton provides

Look in the Student Learning Outcome (SLO) Documents for guidance on when this should be taught. These can be found on the BPS Science Department's website: http://bpsscience.weebly.com/ You will find the Student Learning Outcomes documents organized there by grade level.

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How many different kinds of insects can you think of? Ten, twenty, thirty? Let's see, there are ants, butterflies, cockroaches, bees, flies...uuuh, grasshoppers, mosquitoes, crickets.

Thirty different insects sounds like a lot, but it's not. There are *millions* of different species of insects. In fact, there are more species of insects in the world than all other kinds of organisms combined! This huge number of species makes insects the most diverse group of organisms on the planet, and they outnumber all the other kinds of *animals* many times over. It has been estimated that there are 200 million insects for every human occupying this planet.

Insects have not invaded the sea, but they definitely rule the land. They are the chief consumers of plants; they are the major predators of plant eaters; they play a major role in recycling dead organisms (ants alone scavenge 90% of the dead organisms in their size class); and they serve as food for countless other animals. Insects play a critical role in pollination. Without insects many plants would die out because they could not reproduce. The diversity of insects is phenomenal.

How did insects become so successful? There are lots of reasons—size, mobility, reproductive potential, and structure, to mention a few. Structure is a good place to start.

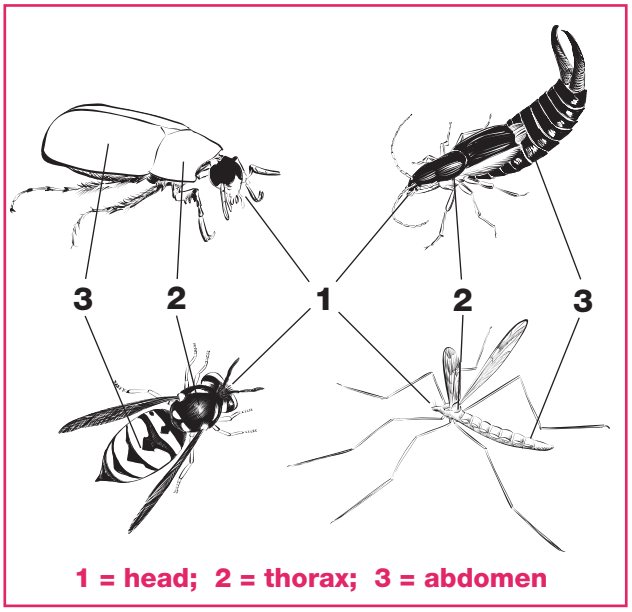
INSECT STRUCTURES

Insects are covered head to toe with a tough, rigid, watertight **exoskeleton.** This protective outer covering is the insect's version of the suit of armor a knight might have worn during the Middle Ages. The exoskeleton provides protection for internal organs, anchors the muscles, and keeps the insect from drying out. The exoskeleton is made of a strong, lightweight substance called **chitin** (KY•tin). Chitin is also the base material in horn and is similar to fingernail.

The insect body is always divided into three regions: **head, thorax,** and **abdomen.** The head is the business end, furnished with a mouth, some sensory equipment, and a primitive little insect brain.

The middle region (the thorax) specializes in mobility. This is where insects have their six legs (*always* six) and wings.

The back end is the abdomen, where most of the guts are. These include digestive organs, reproductive organs, and most of the circulatory and respiratory apparatus.



1 = head; 2 = thorax; 3 = abdomen

The three body sections, wings, tough exoskeleton, and especially the six legs are the characteristics that define an insect. It's absolutely amazing what insects have managed to do with these fundamental structures to produce the most diverse collection of animals on Earth!

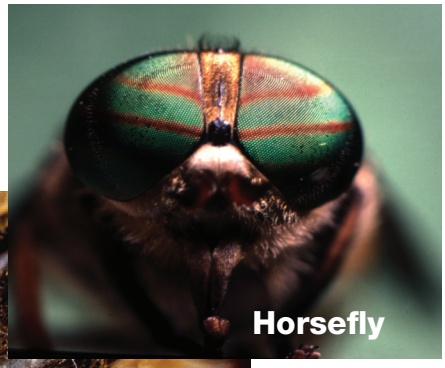
THE HEAD

Insect mouth parts tell us a lot about the feeding habits of a particular species. They vary widely in shape and function, but all have the same basic parts. They include an upper lip, jaws, a second set of smaller jaws, a tongue, and a lower lip. The mouth can be adapted for chewing (beetle and grasshopper), piercing/sucking (bug and mosquito), sponging (housefly), or siphoning (butterfly and moth).

Another head structure you may have noticed is the **antenna.** Insects always have two antennae, usually positioned near the eyes. These are movable and allow insects to sense odors, vibrations, and other information about their environment. Antennae come in a huge range of sizes and shapes, and may even differ between male and female of a species.

Eyes provide insects with information about light in the environment. Insects can have two kinds of eyes. You may have seen pictures of the large **compound eyes** located on the sides of the head, which detect color and motion. Flies and bees have well-developed compound eyes. These eyes are made of many small lenses (up to 25,000), each of which sends a message to the brain. The image quality of these compound eyes is not known, but many scientists think that it would be similar to watching a thousand TV screens at once, with each screen showing an image of the object as seen from a slightly different angle.

Insects also have another set of eyes, the **simple eyes.** These eyes register changes in light intensity only. With these simple eyes an insect can detect day length and determine seasons. Day-length information somehow programs insects' bodies to get ready for reproduction, migration, hibernation, and other activities.



THE THORAX

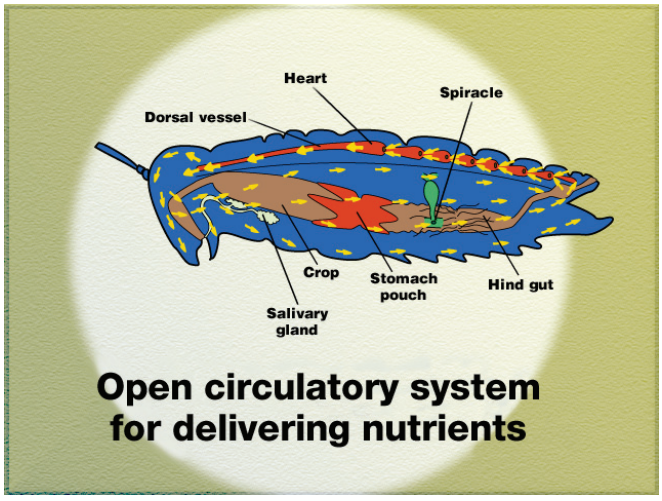
The thorax is divided into three distinct segments. One pair of legs is attached to each segment of the thorax. The wings are attached to the last two segments. Some adult insects may not have wings, or may have only one pair. In some groups of insects (such as beetles) the front pair of wings has evolved into a hard protective covering for the second pair of wings, the thorax, and abdomen. Some insects have ridges on their wings that produce sound when rubbed together. Examples of this behavior include the familiar chirping noise of the cricket and the maddening drone of the cicada.

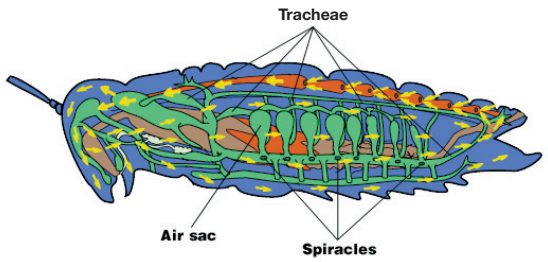
If you have ever seen a grasshopper jump, an ant scurry across the ground, or a cockroach sprint across the floor, you already know that insects have different types of legs. Insects have legs adapted for springing (grasshopper), running (roach), swimming (water boatman), digging (mole cricket), and grasping (praying mantis).

Insect legs also display marvelous adaptations for specialized activities. Honey bees have bristles on their hindmost legs that hold large wads of pollen, and flies have sticky pads on their feet that allow them to walk up smooth surfaces like glass. Many insects have uniquely shaped hooks, spines, and bristles on their legs for holding onto twigs and leaves, and for personal grooming. Insects are constantly cleaning their eyes, faces, and antennae to ensure that their sensory tools are in prime condition.

THE ABDOMEN

The abdomen contains the guts of the insect. It is here that you will find the heart, intestines, and reproductive organs. Did you notice that lungs were not mentioned? That is because insects don't have any! Insects have blood, but it doesn't carry oxygen. Insect blood flows around the gut, where it picks up goodies from the digested food. The blood then carries these nutrients to the cells, and carries away waste products.





Insect tracheal system for gas exchange

Insect cells get oxygen from a huge network of hollow tubes called **tracheae.** The tracheae branch out to provide oxygen to every cell in an insect's body, and are connected to outside air by openings on the abdomen called **spiracles.** The tracheal system of insects is similar to our circulation system (veins, arteries, and capillaries) in that it serves every cell, but it contains only air. Oxygen enters the cells right through the cell membrane by a process called diffusion. In this same manner carbon dioxide leaves the cell, goes through the tracheae, and out of the insect's body through the spiracles.

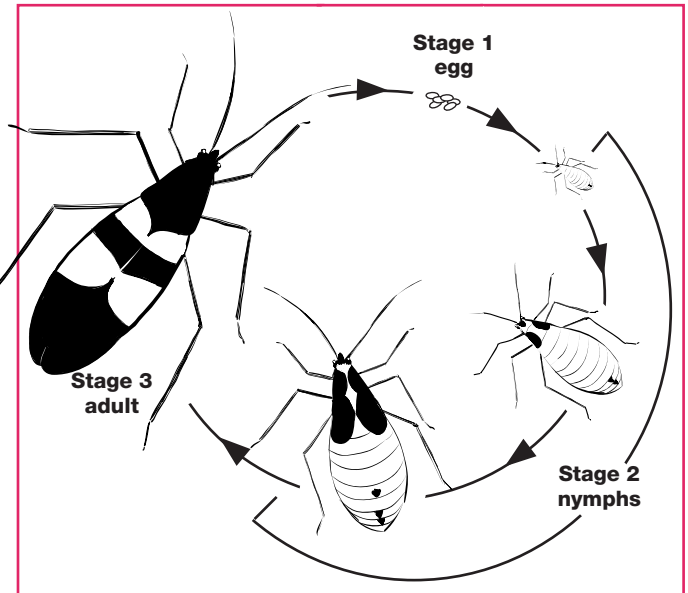
INSECTS' GROWTH

As an insect eats, its muscles and organs get bigger. But there is a problem—the insect is encased in its exoskeleton, which cannot expand. The only way an insect can grow is to shed the skin that it has outgrown and get a new one. This process is **molting.**

When the internal signal to molt is sounded, the insect produces a new exoskeleton *under* the existing one. Then the back of the old exoskeleton splits open and the insect crawls out. The new exoskeleton is soft and rubbery. The freshly molted insect pumps up and expands the flexible new exoskeleton. Within a few hours the new armor hardens, and the enlarged insect gets back to its business. The molting process occurs several times during the life of an insect, and stops when the insect reaches its adult stage.

Usually the molting process also changes the body structure of the insect. When the body structure of an insect changes, it is called **metamorphosis.**

There are two types of metamorphosis, complete and incomplete. Insects that develop by **incomplete metamorphosis** have three life stages. The first stage is an **egg.** The second stage is a series of three or more **nymphs** that look pretty much like miniature adults without wings. During this stage each molt produces a larger, more mature nymph. The final molt results in the sexually mature **adult.** Examples of insects that have incomplete metamorphosis are grasshoppers, roaches, true bugs, dragonflies, and praying mantises.

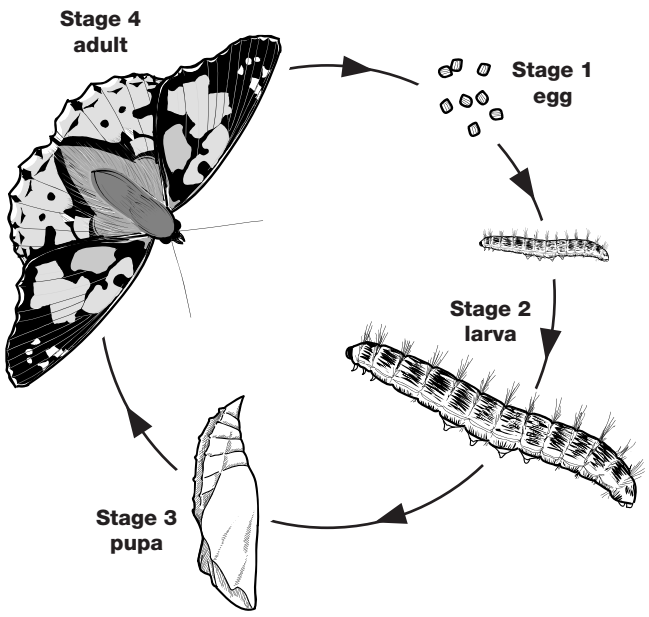


Incomplete metamorphosis: Milkweed bug

Insects like beetles, moths, and butterflies develop differently. These insects undergo **complete metamorphosis.** This is a much more

dramatic story. Complete metamorphosis involves four life stages. Once again the insect starts as an **egg.**

When the egg hatches, out comes a **larva.** Larvae don't look at all like the adults that they will eventually become. Larvae are sometimes



Complete metamorphosis: Painted lady butterfly

mistakenly called worms, like the larva of the darkling beetle, called the mealworm, or the larva of the wax moth, called the waxworm. Larvae are also called grubs and maggots. Even though the larva does not look very much like what we generally expect an insect to look like, close observation will reveal six legs and simple eyes, putting it in the insect clan.

The larva's mission in life is to eat, grow, and store fat. After several weeks, months, or (rarely) years, an internal signal starts an incredible process. The larva molts one last time and emerges as a **pupa.** The pupa lapses into a period of quiet transformation, often enclosed in a chrysalis or cocoon. During this time the internal structures of the larva literally melt down and are reassembled into new structures. Often one of the most spectacular changes is the appearance of wings. After a period of days, weeks, or months, the pupa splits and the final molt reveals the **adult**—perhaps a fly, beetle, bee, mosquito, butterfly, or moth. And away flies the sexually mature adult to locate a mate and produce the eggs for a new generation.

Insects are all around us. They have been on this planet for 400 million years, so they have a successful track record. They continue to fascinate scientists with their diversity and their unusual structures and behaviors. In fact there are so many kinds of insects that new species are being found every day!

Because insects are so well adapted to eating our food supplies, clothing, and homes, effective at spreading disease, and armed with weapons to cause us extreme personal pain, we are constantly in conflict with them. It looks, however, like a losing battle. It is unlikely that we will ever manage to do away with the insects that compete for our resources. Insects in many ways rule this planet by controlling many of the systems we depend on for our survival. Without the important jobs insects do, our environment would deteriorate, and along with it the human race.

The Insect Empire (Diversity of Life – Grade 7)
Student Questions

1. Using the clues present in paragraph 2, explain what the word “diverse” means.

2. According to the text, what are three ways that insects are a useful part of the ecosystem?

3. In the section titled, *Insect Structures*, the author describes the exoskeleton. In your own words, describe what the exoskeleton is like (its characteristics) and what it is for (its functions).

4. In paragraph 9 (top of page 56), the author refers to the wings, exoskeleton, and legs as fundamental structures. What are other words the author could use instead of fundamental and structure that would still give this sentence the same meaning?

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5. In paragraphs 10 - 13, the author describes four major structures located on the head. One of the structures described is the mouth, which is used for feeding. The other three structures (antenna, compound eyes, simple eyes) are all used by insects to gather important information about their surroundings. Compare and contrast the kinds of information each of these three structures gives to an insect.

6. Compare and contrast the two types of metamorphosis (complete and incomplete) regarding insect life cycles.

7. Based on the reading, explain in your own words why insects are so successful.

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Sample Answers

1. **Using the clues present in paragraph 2, explain what the word diverse means.**
   In paragraph 2, diverse refers to the different species of insects.

2. **According to the text, what are three ways that insects are a useful part of the ecosystem?**
   Insects recycle dead organisms, are food for other animals, and help pollinate plants.

3. **In the section titled, *Insect Structures*, the author describes the exoskeleton. In your own words, describe what the exoskeleton is like (its characteristics) and what it is for (its functions).**
   The exoskeleton is like an outer shell (or suit of armor) that protects the organs, connects the muscles, and keeps the insect from drying out.

4. **In paragraph 9 (top of page 56), the author refers to the wings, exoskeleton, and legs as fundamental structures. What are other words the author could use instead of fundamental and structure that would still give this sentence the same meaning?**
   The author could have described them as basic and body parts.

5. **In paragraphs 10 - 13, the author describes four major structures located on the head. One of the structures described is the mouth, which is used for feeding. The other three structures (antenna, compound eyes, simple eyes) are all used by insects to gather important information about their surroundings. Compare and contrast the kinds of information each of these three structures gives to an insect.**
   All of these structures help the insect gather information about their environment. The antennae are used to sense odors and vibrations. Both types of eyes help the insect gather information about light in the environment. The compound eyes detect color and motion. The simple eyes detect changes in light intensity so that the insect knows the day-length.

6. **Compare and contrast the two types of metamorphosis (complete and incomplete) regarding insect life cycles.**
   Both types of metamorphosis go through the process of molting. Incomplete metamorphosis has three life stages: egg, nymph, and adult. Complete metamorphosis has four life stages: egg, larva, pupa, and adult. During complete metamorphosis, the "internal structures of the larva literally melt down and are reassembled into new structures".

7. **Based on the reading, explain in your own words why insects are so successful.**
   Insects are successful because they are well adapted for survival. They are small and numerous, and a necessary part of the ecosystem.

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