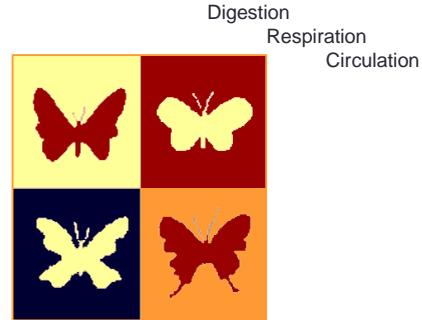


MAINTENANCE



1

INTRODUCTION

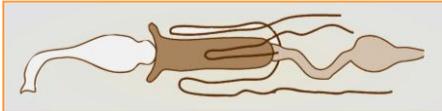


2

OBJECTIVES

By the end of this unit you should be able to:

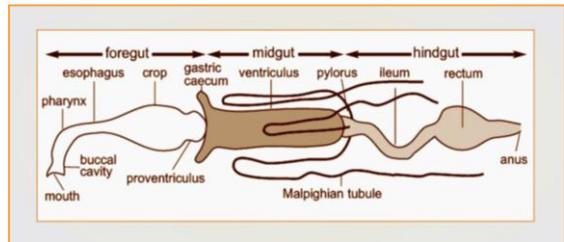
1. Describe the embryonic origin of alimentary canal divisions.
2. Draw and label generalized alimentary canal and describe function of each component.
3. Draw and label generalized insect circulatory system and describe circulation pattern.
4. Describe the tracheal system of insects and define trachea, tracheoles, and taenidia.
5. Describe how insects maintain proper body temperature and how they keep from freezing.



3

ALIMENTARY CANAL

To complete this portion of the unit fill out the corresponding study guide questions and diagram 1.



When you are finished finding all the functions and labeling the diagram, review them for a minute because you will take a self-check quiz on the next slide that is designed to help you remember the functions.

4

SUMMARY OF FUNCTIONS

The table below lists each digestive structure and its function. Make sure you have table 1 and diagram 1 on your study guide properly filled out.

Structure	Function
preoral cavity	The mouth opens into the preoral cavity which grinds and receives the food as it first enters the body.
pharynx	The first region of the foregut which is heavily muscled to help in swallowing.
Esophagus	Swallows food and dumps it into crop.
salivary gland	Secretes fluid to lubricate food as it passes out of pharynx and down the esophagus and into the crop. Secretes some digestive enzymes.
crop	Stores food while midgut enzymes (in some insects) are allowed to enter through proventriculus to digest the food.
proventriculus	Acts as a valve between crop and midgut. It often contains heavy teeth for further grinding of food.

5

SUMMARY OF FUNCTIONS (CONTINUED)

Structure	Function
midgut	Secretes digestive enzymes and the peritrophic membrane. It absorbs nutrients from food broken down by digestive enzymes.
gastric caeca	Fingerlike pouches off the midgut. They are known to house symbiotic bacteria.
Malpighian tubules	Filters harmful substances and nitrogenous waste from the hemolymph.
peritrophic membrane	Membrane secreted by the midgut cells. Protects the cells of the mid- and hindgut. Encloses the food but is permeable to enzymes and permits digestive products to leave and be further digested or absorbed by the midgut cells.
ileum	First part of the hindgut, larger than the colon.
colon	Narrower portion of the hindgut.
rectum	Posterior part of the hindgut. Dehydrates waste and compresses it into pellets.
anus	Expels compressed waste out of the insect's body.

(modified from Gullan & Cranston, 1995, pg. 80)

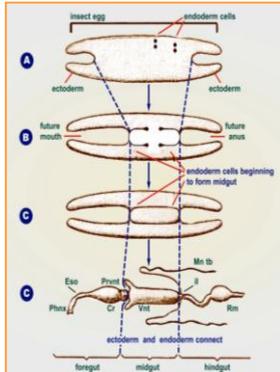
6

ALIMENTARY CANAL EMBRYONIC ORIGIN

As an insect egg develops there are two layers of cells within the egg: an inner layer called the **endoderm** and an outer layer called the **ectoderm**.

Since the foregut and hindgut develop from the ectoderm, they have a cuticular lining similar to the outer cuticle that makes up the exoskeleton. Just as the exoskeleton is made up of chitins and proteins, so is the cuticular lining in the digestive tract. **When the insect molts, this lining is shed along with the exoskeleton.**

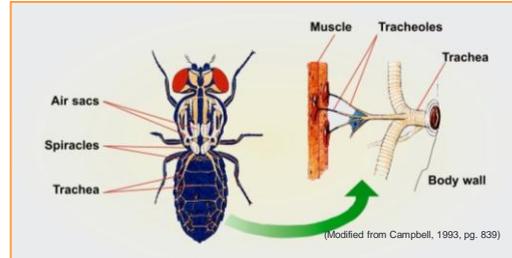
Phx: Pharynx, *Eso*: esophagus, *Pvnt*: proventriculus, *Cr*: crop, *Vnt*: Ventriculus, *Mn tb*: malpighian tubules, *Il*: ileum, *Rrt*: rectum. (Modified from Etzings, 2000, pg. 69).



7

INTRODUCTION - TRACHEAL SYSTEM

Air enters the body through tiny holes called **spiracles**. They control how much air is allowed into the insect body. These spiracles open into tubes called **trachea**, which in turn branch into tinier **tracheoles**. This branching gets the tracheoles within a few cell diameters of each cell. This is important because each cell needs to have oxygen available on demand. When cells need more oxygen, the spiracles open and air rushes in.



(Modified from Campbell, 1993, pg. 839)

8

TAENIDIA



Tracheal tubes of the Canna leaf roller caterpillar.

The maintain flexibility without collapsing because of thickened bands called **taenidia**.

The trachea have an inner lining similar to the outer cuticle of the insect's integument. At each molt, portions of this lining are routinely removed and replaced as the new cuticle is made.

9

VIDEO - TRACHEA ANIMATION

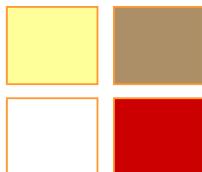
IMPORTANT NOTE:

Throughout the course units, you will be asked to view short video clips. Please understand that many of these video clips are copyrighted and are NOT to be used outside of this class and only may be used for this semester. Please do not copy or distribute these clips.

10

INTRODUCTION - CIRCULATORY SYSTEM

Have you ever seen a bug hit the windshield?



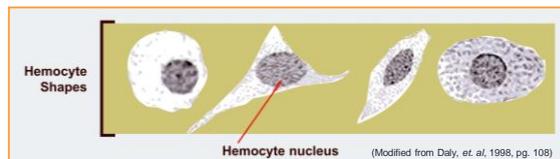
What color is insect blood?

Surprisingly, insect blood is not red. It is usually clear, but can be a greenish, or yellowish in color. Insect blood is not red because it lacks the red pigment hemoglobin. Hemoglobin not only gives our blood the characteristic crimson color, but it also carries the oxygen from our lungs to our cells, a function insects use their tracheal system for.

11

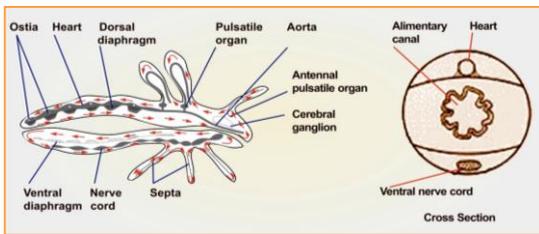
HEMOLYMPH

Insect blood is called **hemolymph**, because it really is not blood, *per se*, but a body fluid, similar to our lymph fluid. Hemolymph cells, called **hemocytes**, can have various shapes and functions.



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CIRCULATORY SYSTEM



(Modified from Daly, et. al, 1998, pg. 108)

13

DORSAL VESSEL

The part of the vessel that has the **ostia** is called the **insect heart** since it does the pumping and the remainder of the vessel is called the **aorta**.

Hemolymph is helped into the antenna and wings by **pulsating organs**.

The wing pulsating organ pumps the blood into **wing veins**.

Butterfly wing venation



The insect's leg is usually divided by a membrane called a **septum**.

One side of the membrane is for the hemolymph to enter, and the other side for it to exit.

14

MAINTAINING BODY TEMPERATURE

Insects can be found in almost any environment on Earth. They have adapted to living in very cold as well as very hot habitats. Some insect hemolymph even contains a type of anti-freeze.

Terms:

- Ectothermic
- Endothermic
- Cold Hardiness
- Freezing-susceptible
- Freezing-tolerant



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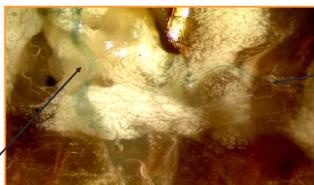
Learning Game Placeholder
Learning Game: Choices
Title: Review Quiz

CONCLUSION

Apply your knowledge:

What would happen if you held an insect's head under water?
 Would stopping the dorsal organ lead to immediate death?

Ponder these questions as you digest the information you have learned.



trachea

tracheole

American cockroach tracheal system dyed blue.

17

REFERENCES

1. Campbell, N.A. 1993. *Biology*, 3rd Ed. Benjamin/Cummings Publishing Company, Inc. Redwood City.
2. Daly, H.V., J.T. Doyen, and A.H. Purcell, 1998. *Introduction to Insect Biology and Diversity*, Oxford University Press, New York.
3. Dow, J.A.T. 1986. Insect midgut function. *Advances in Insect Physiology*, 19, pp. 187-328.
4. Elzinga, R.J., 2000. "The Insect Internally," in *Fundamentals of Entomology*, Prentice Hall, Upper Saddle River, New Jersey, 5th ed.
5. Gullan, P.J. and P.S. Cranston, 2005. *The Insects: An Outline of Entomology*, Chapman and Hall, London.

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