Maggie L. Walker GOVERNOR'S SCHOOL for Government and International Studies

AP Summer Assignment	
Course: AP Biology	
Assignment title	**Principles of Life & Scientific Investigation:** Science Practices, History of Life, Homeostasis, & Animal Behavior
Date due	Part 1 – Textbook Assignment (Chs. 1, 29, 18, & 40) Part 2 – Case Study - "Do Grasshoppers Sweat?"
Estimated time for completion	4-6 hours
Resources needed to complete assignment	☒ School assigned textbook ☐ Student purchased book(s) ☒ Other supplies: computer, calculator, case study handout
How the assignment will be assessed	The textbook assignments and case study will be evaluated for correctness of answers to questions.
Purpose of assignment	☒ Review of foundational material/concepts/skills. ☒ Expose students to required material/concepts/skills/texts that cannot be covered during the academic year. ☒ Have students read material that will be discussed or used in class at the beginning of the year.

AP Biology Summer Assignment

Welcome to AP Biology! This course is designed to be the equivalent of a two-semester introductory biology course usually taken in the first year of college. In other words, it's a little like drinking from a fire hose. It will be a rewarding experience, but as with most things that are, it will also be challenging. Throughout the course, you will become familiar with major recurring ideas that persist throughout all topics and material.

The 4 Big Ideas of AP Biology
Big Idea 1: The process of evolution drives the diversity and unity of life. **Big Idea 2:** Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis. **Big Idea 3:** Living systems store, retrieve, transmit and respond to information essential to life processes. **Big Idea 4:** Biological systems interact, and these systems and their interactions possess complex properties.

On the pages that follow, you'll find detailed instructions of the two assignments that comprise your summer work for AP Biology. The first assignment is related to becoming acquainted with material/concepts/skills that we will be working with at the beginning of the school year. The second assignment deals with integrating the material, concepts, and skills from the first assignment into a case study. Both of these assignments will give you exposure to the types of assignments you will be expected to complete this year, and the science skills that you will develop and hone throughout the school year.

Both assignments are due on the <u>1st day</u> of AP Biology. Both will be averaged together and counted as a test grade for 1st quarter. <u>No late summer assignments will be accepted!</u>

Included in this packet are the following documents:

Document	**Page**
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• Links to Powerpoint lecture notes	3
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Assignment #2 – Case Study	
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Assignment #1 – Textbook Assignments – due 1st day of AP Biology

Using your textbook, and the links to corresponding Powerpoint lectures, answer the "Active Learning Questions" listed below. Some of them we will be discussing the first day of class; I will be evaluating all questions for correctness and depth of analysis and the quality of your answers.

I have also provided links to several resources that include instruction verbs for writing answers to FRQs (Free Response Questions). To access these resources, you ***MUST*** use your MLWGS Google account – I will not provide any alternative access.

#	Lecture Content	Links
1	Chapter 1 – Principles of Life	https://drive.google.com/file/d/195eVU7vAkKS5BjvcnqDT2WpRNV5p-wQF/view?usp=sharing
2	Chapter 18 – The History of Life on Earth	https://drive.google.com/file/d/1WMVshmVbTc_nHIW2gi1tPJUaP1AhFh6E/view?usp=sharing
3	Chapter 29 – Fundamentals of Animal Function	https://drive.google.com/file/d/1wQc5gQ3a0urWqbIhSP0XBq0W5jE4SDur/view?usp=sharing
4	Chapter 40 – Animal Behavior	https://drive.google.com/file/d/1kFVy8mismww-oV_BGbEW1IeNqFNjNtXv/view?usp=sharing
5	AP Biology FRQ Tips	https://drive.google.com/file/d/11vGutiiV-_bw01mXDZZ7J5AW9W1bhrXI/view?usp=sharing
6	How to Write a Good AP Biology FRQ	https://drive.google.com/file/d/1HmMn9EAvID4LCbmE6bkbgWjK2RX9zw0F/view?usp=sharing

Answers to the Active Learning Exercises are to be *original work* and are not to be copied from a peer – these serve as a log of what you have learned from each textbook chapter. Copying them from a peer and not completing the assignment yourself does you no good. You will receive zero credit if you are found submitting work that is too closely aligned with a classmate's work. The MLWGS Honor Code is in effect for this and ALL assignments throughout the school year.

Chapter 1 - Principles of Life

1. ***Make a list*** of the major characteristics of life. Then, ***evaluate*** whether the following exhibit some or all of those characteristics: a flowering plant, a diamond, and a frog. Be prepared to discuss your list with a partner and then share your list and evaluations with the class.

2. ***Create*** a timeline showing the major events in the evolution of life on Earth. Begin with Earth's formation approximately 4.5 billion years ago, and focus on the sequence of events that led to the evolution of multicellularity. Be prepared to present your timeline to a partner, a small group, or the class.

3. ***Select*** the *false* statement about oxygen (O_2) and ***justify*** your answer with evidence:
   A. There was little or no O_2 in the atmosphere of early Earth.
   B. Once photosynthetic prokaryotes became abundant on Earth, O_2 began to accumulate in the atmosphere.
   C. The presence of O_2 allowed aerobic metabolism.
   D. The ozone layer served as the source of Earth's O_2.
   E. O_2 in the atmosphere made it possible for life to move from water to land.

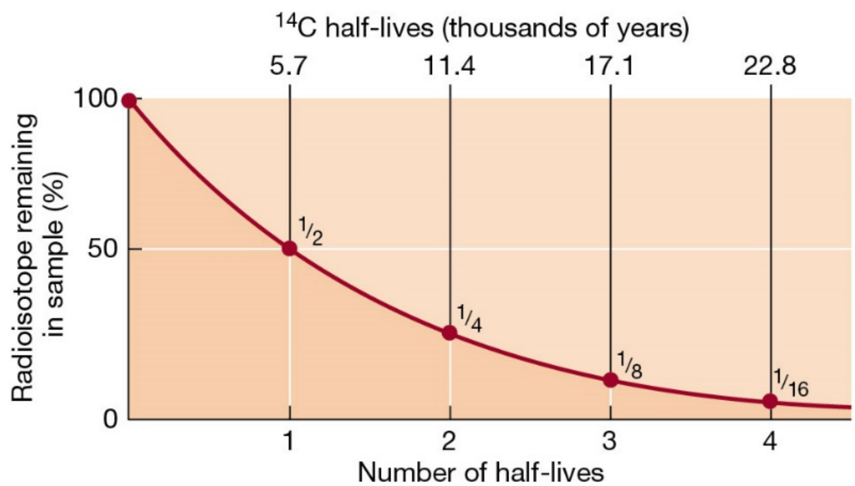
4. Suggest the factors that should be included in ***proximate explanations*** for
   A. the stripes of tigers, and
   B. the reflex that causes you to jerk your hand away from a hot flame.
   Then suggest the factors that should be included in ***ultimate explanations*** for these same phenomena.

5. Consider an experiment designed to test the hypothesis that hormones produced by rat testes are responsible for aggressive behavior. In an experimental group, rats' testes were surgically removed. In a control group, rats' testes remain intact. After the experimental group recovers from surgery in individual cages, experimenters measure the latency of each rat to attack another male rat that is introduced to its home cage. ***Discuss*** the following:
   A. What are the dependent and independent variables?
   B. Does the control group consist of unmanipulated males? Why or why not? Would you include an additional group (or groups) in your study? If so, ***describe*** the groups.

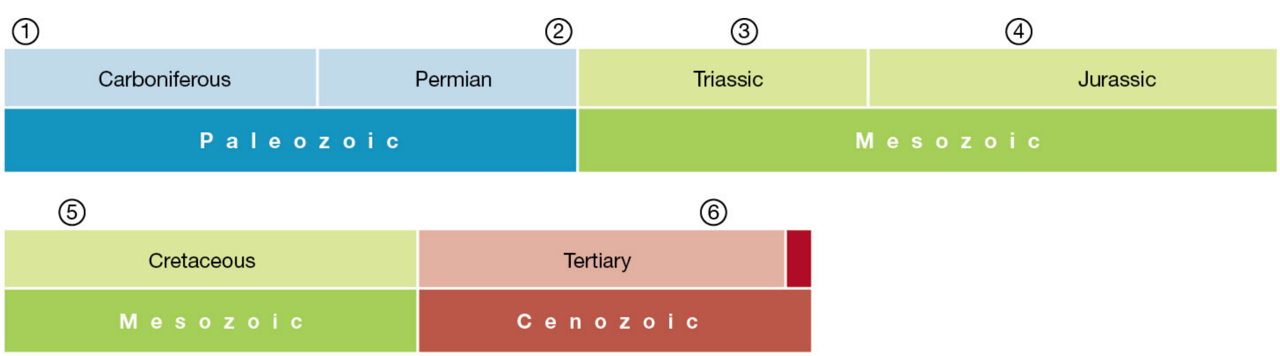
Chapter 18 – The History of Life on Earth

1. We know that the half-life of ^{14}C is 5,700 years. Using the graph below, ***determine*** the solution for the following problem: If you start with 1000 grams of ^{14}C, how much will remain after 70,110 years?
   A. 20 grams
   B. 2 grams
   C. 0.2 grams
   D. 0.002 grams
   E. None of the above

Support your answer choice with data.



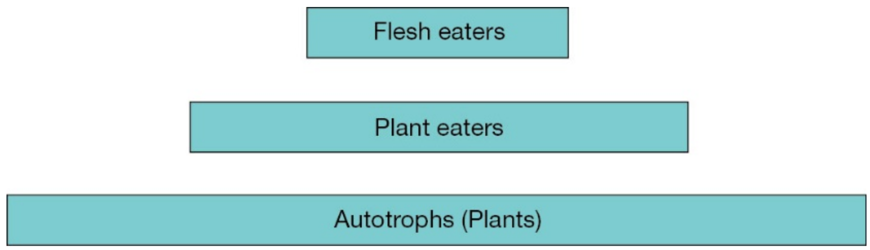
2. ***Match*** each of the events liste with the appropriate number on the timeline below.
   A. Flowering plants diversify.
   B. First mammals appear.
   C. Grasslands spread as climate cools.
   D. Landforms cluster together, forming Pangaea.
   E. Dinosaurs and ray-finned fishes diversify.
   F. Ninety-six percent of Earth's species become extinct.



3. An area of sedimentary rock is excavated, and the fossils discovered there are dated to the Carboniferous period (359–297 mya). Students working at the dig site examine the fossils and conclude that all organisms from the Carboniferous period had hard skeletons. Based on what you have learned about the fossil record, ***evaluate*** the validity of this conclusion. Be prepared to discuss your answer with the class.

Chapter 29 – Fundamentals of Animal Function

1. The ecological (or trophic) pyramid below represents the amount of energy available to organisms at each level of the food pyramid. There are generally far fewer predators than there are grazers, because there is simply less energy available to predators. If, for example, a mouse consumes 100 calories of grass, and an owl subsequently consumes that mouse, the owl will not have access to the 100 calories consumed by the mouse. ***Discuss*** why this is the case using the concept of bioenergetics.



2. You are following a tame, winter-acclimatized Arctic fox around during a winter in northern Alaska, periodically measuring its oxygen consumption and body temperature. You discover the following:
   - At environmental temperatures between –7°C and +20°C, your fox maintains a normal body temperature and metabolic rate (MR).
   - Above +20°C, the fox's MR begins to rise, and he starts panting.
   - As temperatures drop below –7°C, the fox's MR begins to rise, and he starts shivering. He maintains a normal body temperature.
   - At temperatures below –40°C, the fox's MR rises significantly and he shivers intensely, but he still maintains a normal body temperature. The fox spends most of his time in his den, curled into a round ball, with his nose and feet tucked into his fur.

   One night, the temperature drops to –80°C, and the fox's body temperature begins to drop for the first time. (At this point you bring the fox into your house, place him by the fireplace, and cease the experiment.) ***Determine*** and ***discuss*** your Arctic fox's thermoneutral zone.

3. ***Discuss*** the advantages and disadvantages of being a conformer versus being a regulator, as these relate to body temperature.

4. Which of the following represents an example of phenotypic plasticity? ***Justify*** your answer choice.
   A. Certain plants will produce larger leaves when they grow in shady environments than when they grow in sunny environments.
   B. Sunflowers will gradually turn to face the sun throughout the day.
   C. The temperature at which an alligator develops determines the animal's sex.
   D. Some aquatic invertebrates will develop armored carapaces in the presence of predators but not in the absence of predators.
   E. Octopuses can camouflage themselves by changing the color and texture of their skin to blend in with their surroundings.
   F. Many types of tropical butterflies have distinct forms, depending on the season in which they emerge (i.e., one color pattern associated with the dry season and another with the wet season).

5. In the late eighteenth century, British physician and scientist Charles Blagden gained notoriety for his experiments on how humans and other objects respond to high temperatures. In one such experiment, he placed several men, a dog, and a piece of raw meat in a sauna and gradually increased the temperature to 260° F. After a period of time, the piece of meat had dried out and become thoroughly cooked. The dog was panting but was able to maintain its normal body temperature and showed no signs of distress. The men were not cooked and were, perhaps predictably, simply sweaty. How do you ***explain*** the fact that while the meat was cooked, the men and the dog were not?

Chapter 40 – Animal Behavior

1. ***Discuss*** which of the following behaviors are likely fixed action patterns and which are likely to require learning. ***Explain*** your reasoning.
   A. When Graylag geese find an egg that has rolled out of the nest, they roll the egg back into the nest using their beaks and a series of chin-tucking movements.
   B. When in flight, moths immediately fold their wings together and drop when they encounter ultrasonic sounds.
   C. Ducklings follow the first moving object they see after hatching.
   D. Aggressive behavior in stickleback fish is triggered when the male stickleback sees the red belly of his opponent.
   E. After feeding in the ocean for three to seven years, an adult chinook salmon travels, often hundreds of miles, back to the site of its birth to spawn.

2. Some behaviors in animals and humans are hard-wired. Behaviors like fixed action patterns require no learning and are genetically determined. Other behaviors require experience and learning and interaction with the environment.
   A. ***Discuss*** why it might be advantageous for some behaviors—such as navigation and mating dances in birds—to be hard-wired, while others require learning.
   B. Can you think of any examples of fixed action patterns in mammals, fish, or insects?

3. The text describes the differences between "high-caring" and "low-caring" rats, which differ in terms of how frequently they lick and groom their young while nursing and how much they adopt a favorable posture for easy suckling. In a stressful environment, the offspring of low-caring mothers are more likely to exhibit fear and wait longer to go to food when hungry. How does a rat's early experience influence adult behavior so dramatically? ***Justify*** your answer.
   A. It materially alters the rat's genes.
   B. It shapes the expression of regulatory genes associated with stress response.
   C. It influences subsequent behavior, because rats learn about their environment during a critical period.
   D. It influences the rat's behavior through conditioning.
   E. All of the above

4. ***List*** at least three costs and three potential benefits of living in groups. ***Explain why*** you think it is comparatively rare for top predators to live in social groups (relative to organisms such as primary consumers).

5. ***Discuss*** how animal behavior can work to effectively partition a given habitat into smaller, more isolated territories.

Assignment #2 – Case Study – due 1st day of AP Biology

Complete the attached Case Study – "Do Grasshoppers Sweat? – A Surprising Case of Evaporative Cooling" – and be prepared to discuss it in class on the first day of AP Biology class and turn in your responses.

Use this Powerpoint as a resource for the case study: ***A Presentation to Accompany the Case Study:*** **Do Grasshoppers Sweat (link - https://drive.google.com/file/d/1h5JwZU5kGkDxUWezDY0oKqxIwIBx1-LV/view?usp=sharing)**

NATIONAL CENTER FOR CASE STUDY TEACHING IN SCIENCE

Do Grasshoppers Sweat?

A Surprising Case of Evaporative Cooling

by

John G. Cogan, Emily Hill, and Henry D. Prange

Part I – How Animals Stay Cool

Dr. Henry Prange had just finished giving a lecture on desert animals to his animal physiology class. A particularly inquisitive student stayed after class to discuss various cooling mechanisms, and their conversation centered on interesting behavioral mechanisms employed by desert mammal species. Even after the conversation was over, Dr. Prange kept returning to the question of how animals determine whether they are too hot or too cold.

Dr. Prange designed an experiment to study the behavioral response to different temperature stimuli in a species of mammal. He elected to use mice, as they are common in the physiology lab. He built an "alternative chamber" in which each side was filled with a warmer or cooler temperature than he thought the mouse would prefer. To quantify this, he decided to observe and record the amount of time a mouse would spend in either chamber. Excited and eager to begin his research, Dr. Prange wrote up his scientific experiment and presented it to the head of the physiology lab department.

Questions

1. Give two examples of behavioral adaptations animals could use to keep cool under heat stress.

2. Give two examples of physiological adaptations animals could use to keep cool.

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Part II – A Little Background

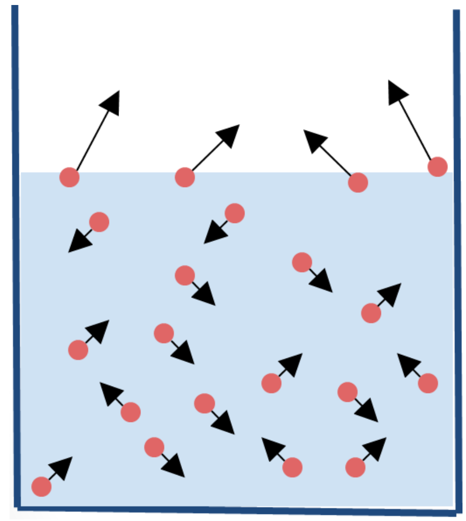

Figure 1. During evaporation, more energetic molecules escape, leaving less energetic molecules behind.

Water is obviously very important to life. One example of how organisms can utilize water to survive is *evaporative cooling*. Evaporative cooling lowers an organism's body temperature through the evaporation of water from respiratory or external surfaces. The fastest-moving water molecules (those with the greatest kinetic energy) gain enough energy to leave a surface. This lowers the average kinetic energy of those water molecules left behind, and in turn lowers temperature. Evaporative cooling is particularly important in large animals (organisms with relatively large volumes relative to small surface areas). Additionally, evaporative cooling increases the relative humidity of an environment, due to increasing the level of water vapor present.

Questions

3. Evaporative cooling, like many biological adaptations, is an emergent property stemming from the basic chemical properties of molecules. Explain some properties of water that allow for evaporative cooling to take place.

4. Evaporative cooling is a product of evolution that has evolved in some organisms for use under certain environmental conditions. Circle the organisms or conditions below that you think are most likely to use evaporative cooling.

Large body size	*Small body size*
Terrestrial organisms	*Flying organisms*
Warm climate	*Cool climate*
Water sources scarce	*Water sources plentiful*

Part III – How Grasshoppers Stay Cool

Unfortunately, Dr. Prange's experiment was rejected. The physiology department had already committed resources to working with specific strains of lab mice; it did not want to risk the chance of contamination with any wild type species. Dr. Prange did not want to give up on his experiment, so he suggested to the physiology department that he use grasshoppers instead. Grasshoppers were readily available, easily bred in captivity, and Dr. Prange saw this as the path of least resistance. The department approved, and Dr. Prange began his experiment on behavioral temperature regulation in the *Schistocerca nitens* species of grasshopper.

Prior to Dr. Prange's experiment, scientists held the belief that, because of their small body size and limited water reserves, grasshoppers (i.e., quiescent insects) were incapable of using evaporative cooling to regulate their body temperature. It was assumed that insects would exclusively rely on behavioral adaptations to keep cool. This phenomenon was well documented and observed.

To begin his experiment, Dr. Prange placed a grasshopper in the warm side of the alternative chamber, which was set to maintain a temperature of around 50 °C. This temperature was generally held to be lethal to an insect. Dr. Prange started the timer and began documenting the grasshopper's behavior. After more than a half hour, he noted that the grasshopper had not moved or shown signs of distress; he assumed it was dead. Dr. Prange reached into the chamber to retrieve the grasshopper, and to his great surprise, it jumped away. Dr. Prange hypothesized that either the grasshoppers had an unusual tolerance for heat, or they were utilizing a cooling mechanism.

Questions

5. From the data acquired in Prange's experiment (Figure 2), determine the temperature that leads to a significant difference between body temperature and air temperature (i.e., greater than about 2 °C difference).

6. As Dr. Prange suggested, the grasshoppers appear to be using some other cooling mechanism(s) besides behavior. Give two examples of cooling mechanisms that grasshoppers in the study might be using.

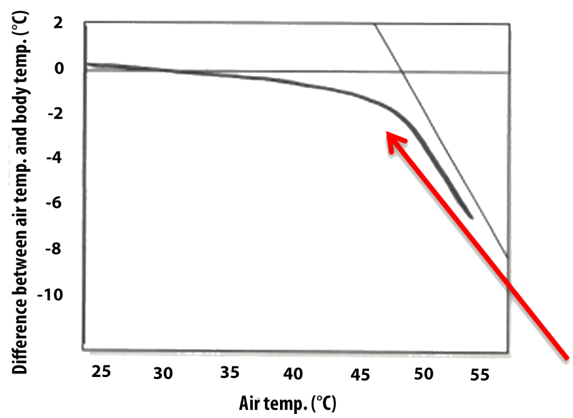

Figure 2. Significant difference between body and air temperature in grasshoppers. Adapted from Prange (1990).

Part IV – What's Going On Here?

Dr. Prange decided to take this experiment a step further. He wanted to know mechanistically how the grasshoppers were able to keep their body temperatures low enough to withstand lethal environmental temperatures. He developed these two hypotheses:

Hypothesis 1: The grasshoppers reduce their body temperature by decreasing their metabolism.

Hypothesis 2: The grasshoppers reduce their body temperature by using an evaporative cooling mechanism.

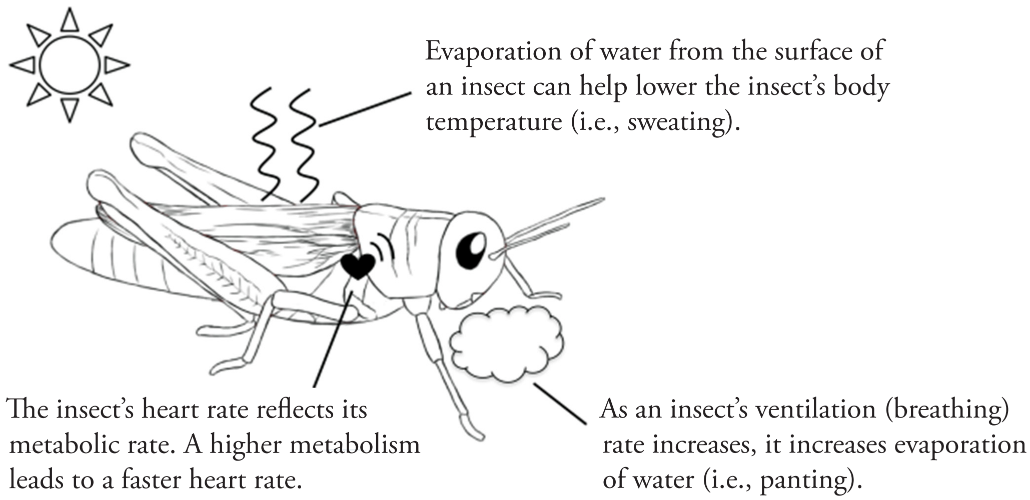

Figure 3. Possible cooling mechanisms in a grasshopper.

Dr. Prange used specific instruments to record the grasshopper's heart rate, ventilation (breathing) rate, and evaporative water loss. He compared these with the organism's body temperature in the three graphs below (Figure 4). From his findings, the ventilation rate increased drastically around a temperature of 45 °C (left graph). The figures for heart rate and evaporative water loss are also shown below.

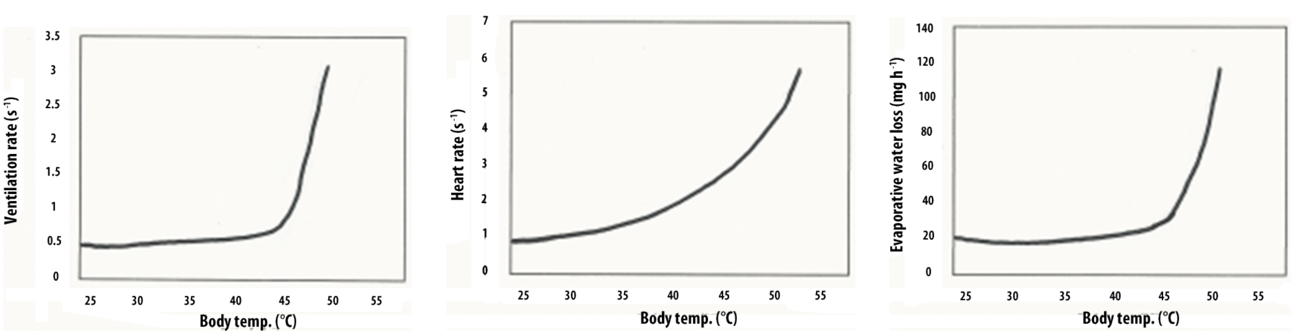

Figure 4. Grasshopper heart rate, ventilation rate, evaporative water loss. Adapted from Prange (1990).

Questions

7. From the graphs in Figure 4, does the increase in ventilation rate appear to be most likely related to an increase in metabolic need (heart rate), or an increase in the amount of water evaporation? Explain your reasoning.

8. Compare the graphs in Figure 4 to the graph in Figure 2. What appears to happen to grasshoppers at a temperature of around 48–50 degrees?

9. From Dr. Prange's study, can it be supported that the grasshoppers were using evaporative cooling? Why or why not?

Bonus

10. Water has an unusually high heat of vaporization (~40kJ/mol), allowing it to be used for evaporative cooling. What do you think would happen if a different compound was used for evaporative cooling—for example, methane (~8kJ/mol)?

References

Asres, A. and N. Amha. 2014. Physiological adaptation of animals to the change of environment: a review. *J. Biology, Agriculture, and Healthcare* 4(25): 146–51.

Prange, H. 1990. Temperature regulation by respiratory evaporation in grasshoppers. *J. Exp. Bio.* 154: 463–474.