MPH AS Biology Summer Assignment

Engagement Questions for *The Serengeti Rules* by Sean Carroll
adopted from curriculum resources by Paul K. Strode

Name:____ Date:___________________

Instructions:
Over the summer, read the book *The Serengeti Rules* by Sean B. Carroll. We will be reviewing the book during the first half of the first quarter, and answering the questions below. You may pick up a copy of the book in my office over the summer, or buy your own. Read the entire book, including the Introduction and Afterword. There are 10 discussion questions below, one for each chapter. I suggest you read the chapters one at a time and answer each chapter question immediately after reading. You may answer your questions by making a copy of the google doc and writing right in the document, or you may print out this packet and hand write your answers as well. Please note that any questions that ask you to "sketch" or "draw" or "graph" must be done by hand. If you have any questions, please email me at ayeager@mphschool.org. Have a great summer!

Chapter 1:

Near the end of Chapter 1, Sean Carroll writes, "Combined with his knowledge of the control of digestion, respiration, heart rate, and the responses to stress in animals, Cannon was provoked to think about the body's ability to react to disturbances and yet to maintain critical functions within fairly narrow ranges."

a. Describe one of Cannon's discoveries that helped lead him to conclude that the body is able to "maintain critical functions within fairly narrow ranges."

b. What term was coined by Walter Cannon to "describe the steady states maintained in the body"?

Chapter 2:

Study Figure 2.4 on page 42 of *The Serengeti Rules*. This figure shows the number of rabbit and lynx furs (pelts) sold by trappers to the Hudson Bay Trading Company of Canada. Now go to Google Images and search "lynx hare population cycle." The graphs that you will see are from textbooks used in biology courses. Compare these graphs to the original Charles Elton graph.

a. Comment on how well the patterns in the textbook graphs match the original graph.

b. How do you explain the differences you see?

c. What was Charles Elton trying to infer from the lynx-hare data? What are the limitations of the inference?

Chapter 3:

Turn to pages 56 and 57 of *The Serengeti Rules*. Here Sean Carroll describes a critical Nature of Science moment in the career of Jacques Monod.

a. Describe the observation Monod made as a result of his experiment, which is illustrated by Figure 3.2.

b. Write the hypothesis Monod proposed to explain his observation.
c. Briefly outline the method Monod designed to test his hypothesis.

d. Write the prediction Monod made for what he expected to see if his hypothesis was supported.

Chapter 4:

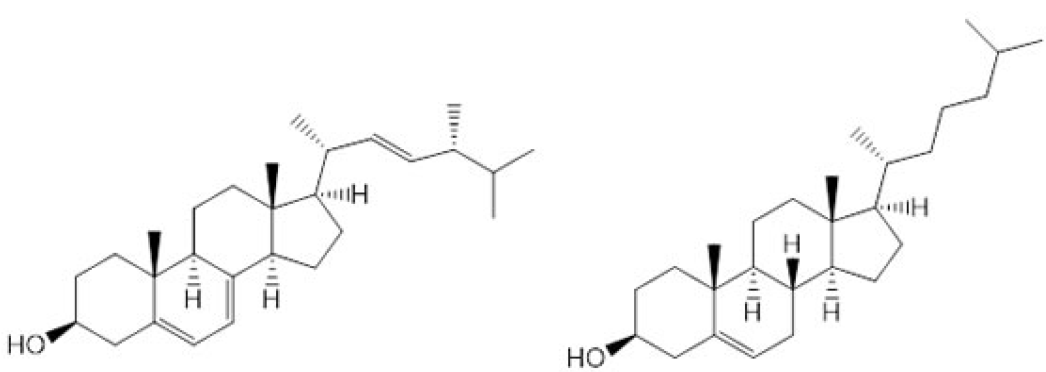
Figure 14 shows the molecular structures of cholesterol and ergosterol. These two molecules are found in the cell membranes of fungi (ergosterol) and animals (cholesterol) and are essential for proper membrane function in both groups of organisms.

a. Identify the class of biological molecules that contains ergosterol and cholesterol: proteins, lipids, carbohydrates, or nucleic acids. How do you know?

b. Why do you think these two molecules are essential for membrane function in fungi and in animals?

c. Explain why Akira Endo studied 6,000 different species of fungi in an attempt to discover an enzyme that might inhibit the synthesis of cholesterol in humans.

d. What do the similarities between the two molecules suggest about the evolutionary relationship between fungi and animals?



Ergosterol
(Fungi)

Cholesterol
(Animals)

Figure 14. The molecular structures of the membrane sterols ergosterol and cholesterol.

Chapter 5:

Sean Carroll explains that two common events in the genesis of cancer are stuck “accelerators” and broken “brakes.” For many of a person’s genes there are two copies, one inherited from a person’s father, and one from a person’s mother. For types of cancer that involve broken brakes and stuck accelerators, which case requires both genes to be malfunctioning? Which requires just one malfunctioning gene? Explain.

Chapter 6:

In a 1980 lecture and associated paper in the Journal of Animal Ecology, Robert Paine introduced the field of ecology to the idea of the trophic cascade. That same year, a group of ecologists led by Peter Price at the University of Illinois published a paper in the Annual Review of Ecology and Systematics, titled “Interactions among Three Trophic Levels: Influence of Plants on Interactions between Insect Herbivores and Natural Enemies.” Without any mention of Paine’s trophic cascade hypothesis (indeed, Price and his colleagues may have not had the chance to read Paine’s paper), the ecologists made the following statements: “Consideration of the third trophic level is indispensable to an understanding of any part of the system. We cannot understand the plant-herbivore interaction without understanding the role of enemies. We cannot understand predator-prey relationships without understanding the role of plants. Enemies [of insect herbivores] should be considered as mutualists with plants and part of plant defense.”

a. How does Jim Estes’s sea otter trophic system relate to these statements?

b. “The enemy of my enemy is my friend” is an ancient proverb that dates back to the 4th century BCE and has been used as a guiding principle during wartime and in other international affairs. How does this proverb relate to Paine’s trophic cascade hypothesis and the above claim by Price and his colleagues?

Chapter 7:

Figure 15 shows the trophic level occupied by a terrestrial animal species as a function of its mean body mass.

a. Which species are herbivores and which are carnivores? How do you know?

b. Taking these terrestrial animals as an entire group, describe the relationship between mean species body mass and its trophic level, and propose an explanation for this relationship.

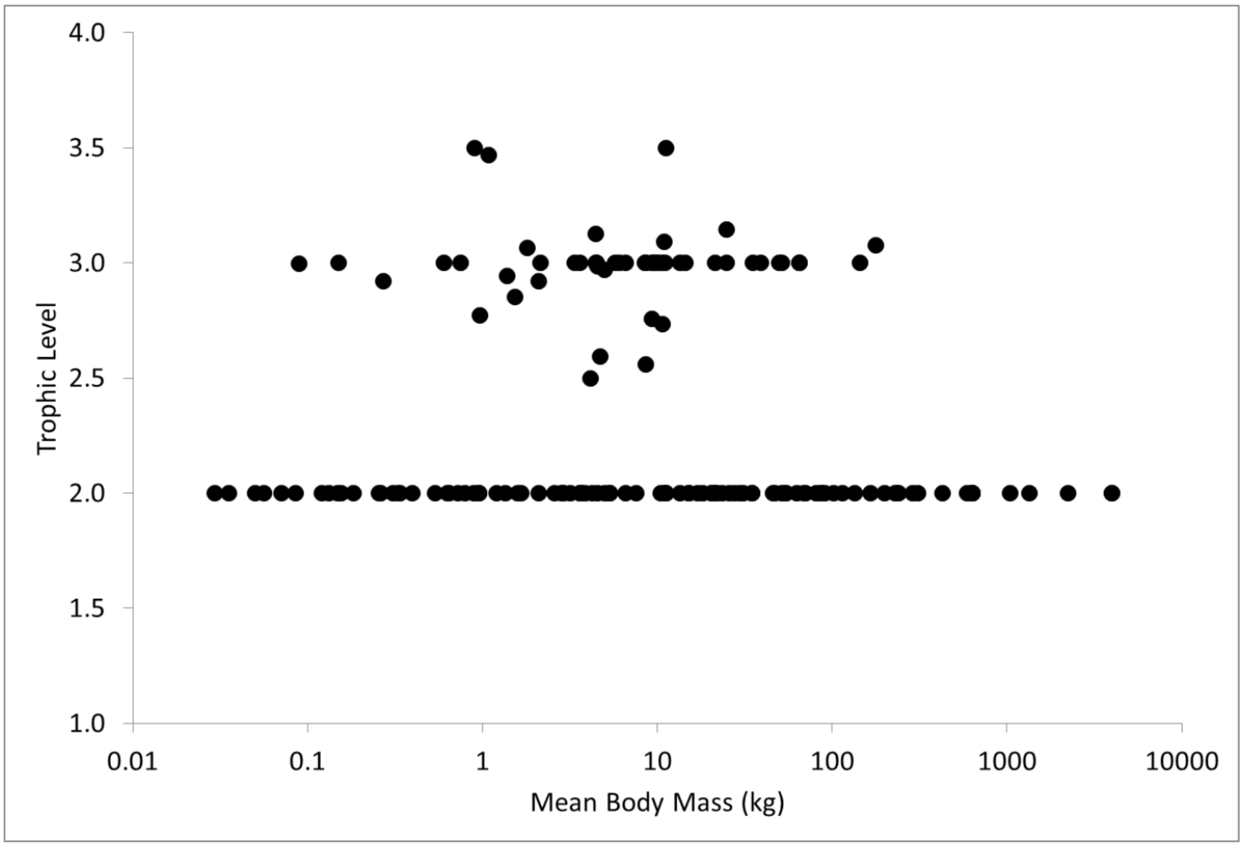


Figure 15. Trophic level as a function of species body mass compared for species occupying terrestrial environments. Each datum represents a species mean value (n = 107 species). Data are from M. A. Tucker and T. L. Rogers (2014). "Examining Predator-Prey Body Size, Trophic Level and Body Mass across Marine and Terrestrial Mammals." *Proceedings of the Royal Society of London B: Biological Sciences*, 281(1797), 2014–2103.

Chapter 8:

Two Swiss ecologists, Oliver Martin and David Hosken, were interested in the relationship between parasites and their hosts. They chose dung flies (*Sepsis cynipsea*) and parasitic mites (*Pediculoides mesembrinae*) that use the flies as hosts to test the hypothesis that parasites compete directly with their hosts for resources and can reduce their ability to survive (i.e., reduce their longevity). The researchers randomly selected 10 male and 10 female flies that had been infected with mites and the same number of flies that had no mites. The experimental flies were placed singly in vials with ample sugar and water and checked daily for death. The longevity for the flies was recorded in days. The researchers' data are recorded in Table 2.

Table 2. Number of dung flies (Sepsis cynipsea) alive as a function of time (days) after inoculation with parasitic mites (Pediculoides mesembrinae). Data are from O. Y. Martin and D. J.Hosken (2009). "Longevity and Developmental Stability in the Dung Fly Sepsis cynipsea, as Affected by the Ectoparasitic Mite, Pediculoides mesembrinae." *Journal of Insect Science*, 9(1), 66.

No mites	Day	0	10	11	12	17	28	34	37	38	39	42	43	44
	# of flies alive	20	18	16	14	13	12	8	6	5	4	3	2	0
Mites	Day	0	5	7	9	10	11	12	14	18	19	28	—	—
	# of flies alive	20	17	15	13	11	9	4	3	2	1	0	—	—

a. Graph the data from Table 2 in a way that you think illustrates how the presence of mites affects the longevity of the flies.

b. Summarize the results of this experiment, and compare the results in light of the researchers' hypothesis.

c. What do the results suggest about the effect of parasites on their hosts? In other words, what hypothesis might explain these results?

Chapter 9:

In Lake Ontario, the native lake trout (*Salvelinus namaycush*) began declining during the first half of the past century. By 1950 the lake trout population of Lake Ontario had gone extinct. In the 1960s, fish biologists began adding lake trout fry (little fish) from fisheries to Lake Ontario to restore the population. These initial efforts were unsuccessful, because the small fish that were stocked were being eaten by invasive sea lampreys (*Petromyzon marinus*). Control of the lampreys began in 1971, and lake trout stocking efforts restarted in 1973. Lake trout stocking increased from 66,000 fish in 1973 to 1.9 million fish in 1985 and was maintained above 2 million fish annually until 1992. By 1993 the lake trout began reproducing naturally. Information from: E. L. Mills, J. M. Casselman, R. Dermott, J. D. Fitzsimons, G. Gal, K. T. Holeck, and E. S. Millard (2003). "Lake Ontario: Food Web Dynamics in a Changing Ecosystem (1970–2000)." Canadian Journal of Fisheries and Aquatic Sciences, 60(4), 471–490.

a. Why do you think it was necessary to add so many fish to Lake Ontario every year?

b. Why were fish biologists from the United States and Canada so interested in restoring the Lake Ontario lake trout population?

Chapter 10:

As Greg Carr and his scientific team planned the restoration strategy for Gorongosa, why did they decide to restore large herbivores like buffalo, zebra, and elephants instead of large carnivores like lions?

Trophic level interactions
Everything stays in place; it shifts, but is controlled; Pressure from both sides
Using real data to make broader conclusions; able to apply it elsewhere
There are rules of nature;
There are goals at both the microscopic levels and whole organisms