ACTIVITY 19: Studying circulation in the tail of a goldfish

Introduction:
In 1628, William Harvey published his finding on the circulation of blood without actually observing the blood capillaries. He hypothesized their existence based on the knowledge that the human circulatory system was a closed one, and some sort of vessel had to connect arteries to veins. In this exercise, you will have the experience of observing circulation of blood through the capillaries in the tail of a goldfish. The importance of the relationship between the bloodstream and the body tissues will become clear.

Using vertebrates in the laboratory requires great care and responsibility. If the procedures below are followed carefully, the fish will still be alive and healthy at the end of the exercise.

Materials: microscopes, battery jar with goldfish, scissors, petri dish, 2 half slides, container with aged water, cotton, fish nets

Procedure & Observations:
Before beginning the investigation, observe the behavior of the fish in its natural environment. Describe the behavior below. 

Procedure:
1) Obtain a cotton square and separate it into two pieces, one larger than the other.
2) Soak the thin piece of cotton in the aged water and spread it on the bottom of the petri dish toward one end. At the other end, place a half slide.
3) Soak the thick piece of cotton in the aged water and have it ready for step 4.
4) Remove the fish from the water with the net. Place it in the petri dish in such a position that its head and body are on the moist cotton and its tail is on the half slide.
5) Place the thick saturated piece of cotton lightly over the entire body of the fish.
6) Spread the tail out flat and put the second half slide over it so that the tail is sandwiched between the two slides.
7) Remove two small pieces of cotton from your preparation, and place them on either side of the top slide in order to weigh it down (Figure 1).
8) Place the petri dish on the stage so that the fish's tail is over the stage opening.
Observations:
1) Using low power, focus on the tail. **Note: Remember that the direction of movement is reversed under the microscope.**
2) Scan the lower end of the tail observing the relationship between the blood vessels and body tissues. Describe and explain what you see. ________________

_______________
_______________
_______________

3) Using your fine adjustment, locate and identify the skeletal rays. Draw a section of the tail and label each of the structures mentioned in the laboratory exercise, i.e. arterioles, venules, capillaries, and skeletal rays.
4) Concentrate on the pulse and the rapidly moving blood in the arterioles. Compare this with the more slowly moving blood circulating in the opposite direction in the venules. Look for the blood vessel that links the arteriole to the venule. Name the vessel. ____________________________

5) Given that the average diameter of a goldfish red blood cell (RBC) is 10 µm, calculate the approximate diameters of all three blood vessel types. ________________

______________________________

______________________________

______________________________

6) Compare the rate of blood flow in an arteriole with that in a capillary. ________________

______________________________

______________________________

______________________________

7) Study the RBCs and describe their shape. ________________________________

______________________________

______________________________

8) Find the goldfish's pulse rate. The pulse rate is ______ beats per minute.
9) Carefully place the fish back in the battery jar.

"On-paper Experiment"
In order to spare the goldfish trauma, the results of two experimental conditions are diagrammed below. The questions that follow are based on your interpretation of the diagrams.

Experiment 1: The chemical lactic acid is placed on the tail of the goldfish. The change brought about by this treatment is shown below.
Experiment 2: The chemical nicotine is placed on the tail of the same goldfish after a 24-hour period of recovery. The changes brought about are diagrammed below.

Observations:
1) How was blood vessel size affected by the lactic acid? 

2) How did the nicotine affect blood vessel size? 

---

Figure 3.

Figure 4.
3) Which chemical would be classified as a vasodilator and which as a vasoconstrictor? 

4) Describe the expected effect on overall blood pressure if an organism is exposed to a vasodilator.

5) Describe the expected effect on overall blood pressure if an organism is exposed to a vasoconstrictor.

Note: Another vasodilator is alcohol. Another vasoconstrictor is caffeine.

Discussion:
1. In which blood vessels would you expect to find the greatest amount of exchange between the circulatory system and the body tissues. Explain your answer.
2. Review your description of the breathing behavior of the goldfish. Describe how this breathing mechanism is correlated with the structure of the gills that are bright red in color and made of many folded membranes.
3. The capillary network is found to be denser in muscle tissue than in the tail of the goldfish. What is the adaptive advantage of this difference?
4. Explain why a person under the influence of alcohol would be likely to suffer from exposure to extreme cold?
5. Based on information in this laboratory exercise, explain why a muscle with an accumulation of lactic acid would be served most effectively by the circulatory system.
6. Based on information in this laboratory exercise, explain why nicotine decreases a person's athletic effectiveness.
7. Explain why smoking during pregnancy is harmful to the fetus.