AP® Biology
2002 Sample Student Responses
Form B

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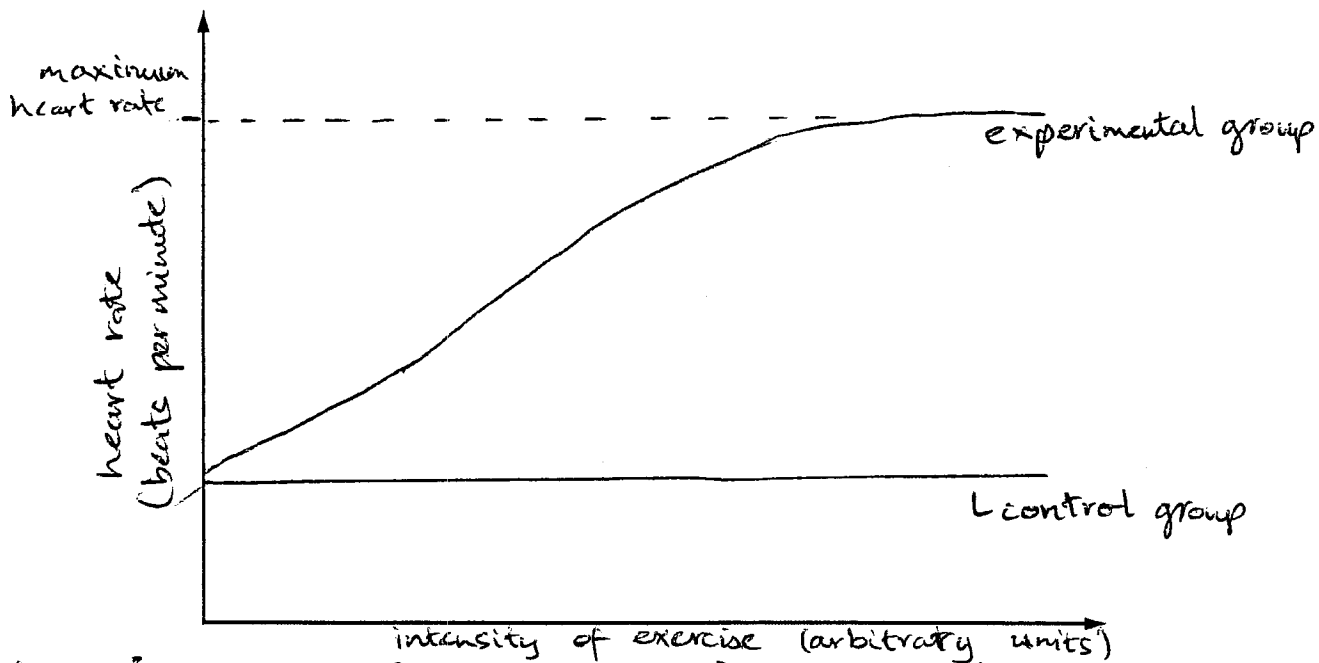
Q2-A
p.1 of 2

2. In mammals, heart rate during periods of exercise is linked to the intensity of exercise.

   (a) **Discuss** the interactions of the respiratory, circulatory, and nervous systems during exercise.

   (b) **Design** a controlled experiment to determine the relationship between intensity of exercise and heart rate.

   (c) On the axes provided below, **indicate** results you expect for both the control and the experimental groups for the controlled experiment you described in part B. Remember to label the axes.



a) As the intensity of exercise increases, the heart rate increases in order to provide oxygen for respiring muscle cells and to remove carbon dioxide and heat. ~~The~~ Chemoreceptors and barroreceptors in the carotid bodies and aorta measure CO_2 concentrations and blood pressure. The breathing rate and depth of breathing increases. Ventilation in the lungs increases. The sympathetic nerves of the autonomic nervous system stimulate the sinoatrical node of the heart. There is faster depolarization and so the rate of heartbeat increases. There is an increased blood flow to the muscle cells. This provides them with more oxygen for aerobic respiration. ~~Resp~~ Respiration releases energy, in the form of ATP, for muscle contraction. The hypothalamus is also involved. If CO_2 concentrations rise above normal, the hypothalamus stimulates the heart to beat faster.

ADDITIONAL PAGE FOR ANSWERING QUESTION 2

b)

b) The independent variable is the intensity of exercise while the dependent variable is the heart rate. ~~The intensity of exercise can be~~ Ask someone to step onto a treadmill and connect wires to his body that allow his heart rate to be measured. The heart rate is measured in beats per minute. Change the speed and inclination of the treadmill to alter the intensity of exercise. The control, in this experiment, is another person of the same age, gender and state of health, sitting down and exerting no physical effort.

Take readings of the heart rate at different levels of exercise intensity. Plot a graph of the results. Repeat the experiment with a different person. Again this person should be of the same age, gender and state of health. The results should concur. Take the average of the results and hypothesize. The experiment shows that as intensity of exercise increases, the heart rate increases. There is a direct relationship between the two variables. The results also show that the experimental group reach a certain maximum heart rate beyond which there is no increase, no matter what the level of exercise intensity is. ~~The~~ In addition, the control group should show virtually no change in heart rate. The graph for the control group remains fairly constant. This is known as the resting heart rate.

Q2 S
p.1 of 3

2. In mammals, heart rate during periods of exercise is linked to the intensity of exercise.

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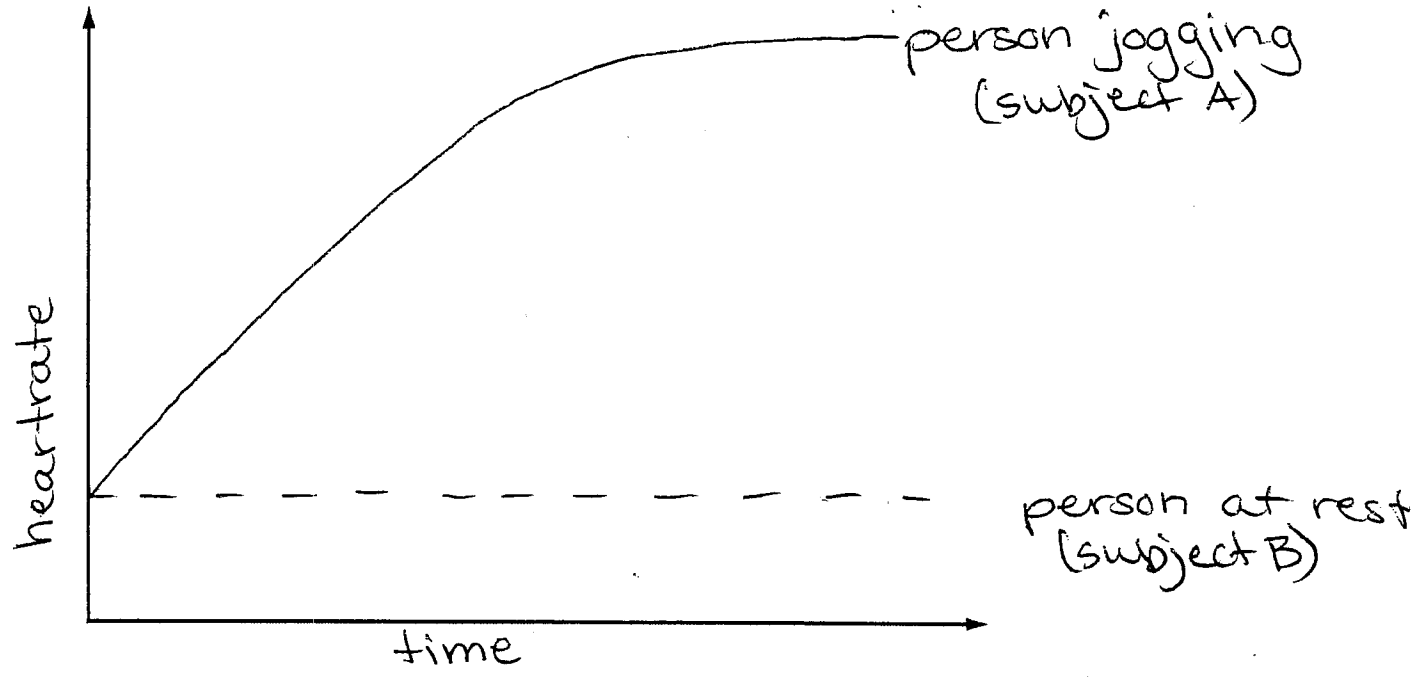

When a ~~person~~ mammal begins to exercise, their sympathetic nervous system causes their heart rate to increase and their bronchial tubes to expand to allow for easier, heavier breathing. More blood needs to be pumped through the body, and more oxygen is needed to be sent through the body with the blood. The sympathetic nervous system allows this to happen ~~easier~~ more easily.

To determine the relationship between intensity of exercise and heart rate, we can compare the heart rates of two individuals, one at rest, and one who is jogging. Both of these individuals

ADDITIONAL PAGE FOR ANSWERING QUESTION 2

should be of the same weight, health, sex, and age to control the experiment. Both volunteers should be hooked up to heart-monitoring equipment. Then "subject A" should begin jogging on a tredmill at a constant speed (to be controlled by the tredmill), and subject B should stay in whatever position he/she is already in. Over a short period of time, their heart rates should be monitored and recorded.

The expected results for the person jogging are that his/her heart rate will increase rapidly at a steady rate until it reaches its maximum, at which point, it will level off. The heart rate of the person at rest will remain as it is, or if the person at rest has come from doing a different activity, the heart rate should decrease slightly.

In a more accurate experiment, both subjects should be sought out in advance and allowed to relax under controlled conditions before the experiment is to begin. Also, this experiment should be repeated multiple times with volunteers of different ages, sexes, weights, and physical ability. Each group of volunteers should take part in the experiment more than once to allow

Q2-5
p.3 of 3

ADDITIONAL PAGE FOR ANSWERING QUESTION 2

for accuracy and comparison. In all cases, though, the expected results should be the same. The repetition is only to make sure.

GO ON TO THE NEXT PAGE.

Q2-T
p.1 & 2

2. In mammals, heart rate during periods of exercise is linked to the intensity of exercise.

   (a) **Discuss** the interactions of the respiratory, circulatory, and nervous systems during exercise.

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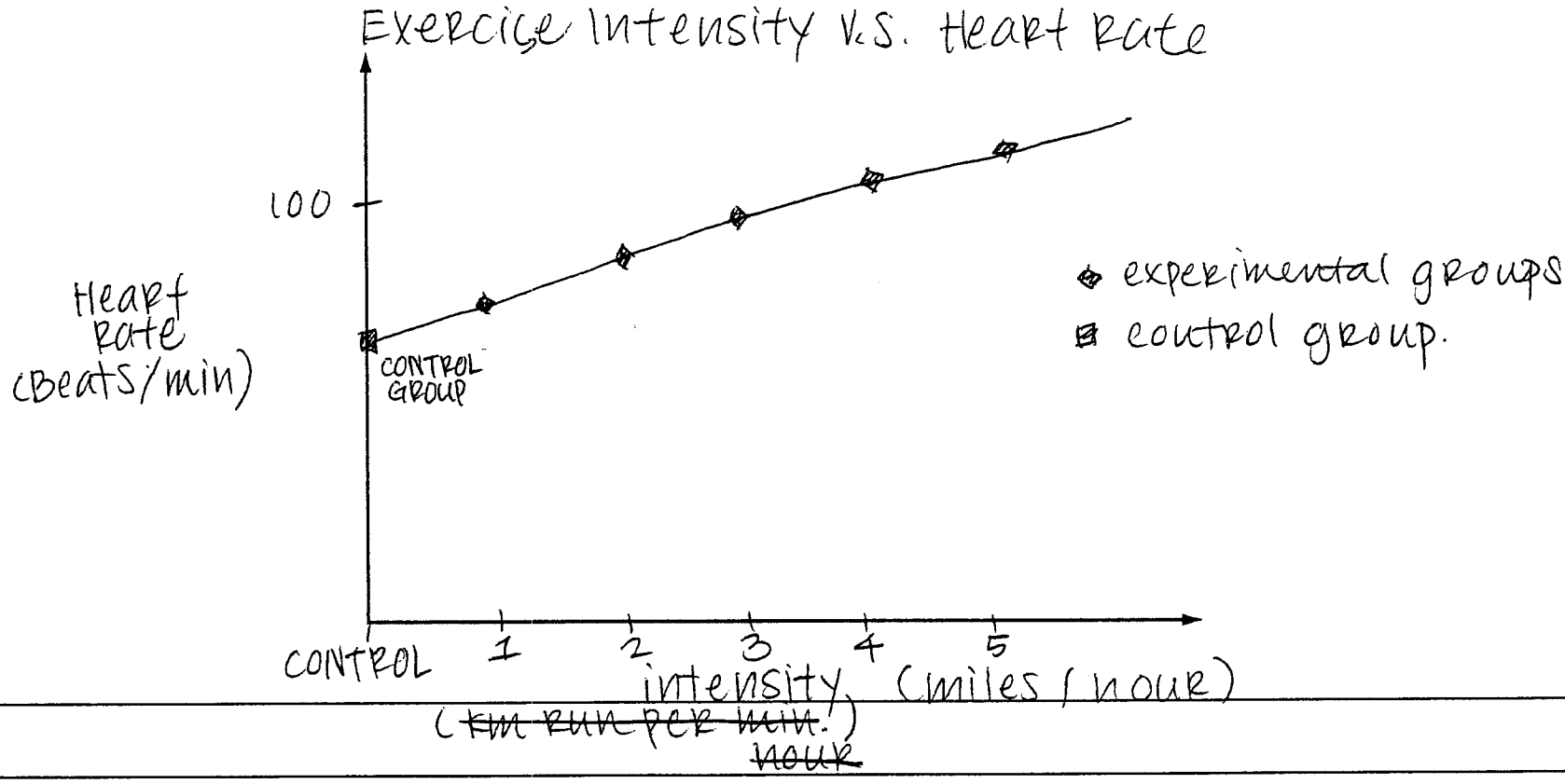

(B) Hypothesis: If the intensity, or kilometers run per minute, increases, then the heart rate will increase as well. Have several people come into a room with a set temperature and running machines, so that the environment will be the same. One day 1, measure their heart rates without prior exercise and record. On day 2, record their heart rates after running at a pace of 1 mile/hour for 10 minutes; on the next day, a pace of 2 miles/hour for 10 minutes. Continue experiment for ~~#~~ 5 consecutive days and record results for each person separately. ~~At the end~~ The control will be the results of day 1, and our tested variable,

Q2-T
P.2 of 2

ADDITIONAL PAGE FOR ANSWERING QUESTION 2

intensity. Average the results for each man and record. The more intense the running, the greater number of heartbeats should take place. There is a positive correlation between the two.

~~During exercise, metabolism increases because of an increase in the production of ATP molecules. As we exercise, our respiratory system takes in more oxygen from the atmosphere. With more oxygen, aerobic respiration speeds up and produces more ATP than usual. These energy molecules then help to generate more movement and muscle contractions. As the oxygen content in our~~

As we exercise, metabolism in our body speeds up and we require more oxygen to provide the energy needed from aerobic respiration. Because a lack of oxygen decreases the amount of ATP produced, we breathe more rapidly to take in more oxygen. With less oxygen in our blood as we exercise, the circulation also speeds up to distribute more oxygen to our body cells. With oxygen, aerobic respiration generates ATP for more muscular movements. Because the process occurs as kind of a cycle, there is a definite correlation between exercise and heart rate. Our heart rate speeds up when our circulatory systems needs to transport more oxygen to our body, and carry away waste products being formed at a faster pace.