

Read each question carefully and don't hesitate to ask if a question seems unclear. If possible, answer each question in the space provided, but if needed, continue on the back. If you use a drawing as part of your answer, be sure to also include a written explanation. These questions have specific answers, although for some, more than one answer is possible. To receive full credit you must clearly and fully answer the question being asked. The points for each question are noted in parentheses totaling 103 points.

1. What are **two** ways that a calcium deficiency would decrease someone's ability to move? (8 pts)
Any two of: Calcium is needed to- Release neurotransmitters from the motor neuron. Move tropomyosin so myosin can pull the actin together. Form bones so the muscles have something to pull against.
2. You and a friend are both sneezed on by someone who has tuberculosis, a bacterial infection. You were both equally exposed to the pathogen, and your friend got sick, but you did not. Why did you remain healthy while your friend got sick? (8 pts)
You were previously exposed to this pathogen (because you were sick or by vaccine) and made memory B-cells, so your immune reaction is so rapid you never get sick.
3. Of the four tissue types in an animal, which are part of the immune system? For each tissue type that is part of the immune system, describe one function of that tissue in the immune system. (8 pts)
*Need at least 2 for full credit. If they have additional correct answers, no problem.
Connective tissue- Blood carries the B- and T-cells. The B- and T-cells come from bone marrow.
Epithelial tissue- The skin serves as a barrier to pathogens.
Muscle tissue- Pathogens trapped in the throat/nose are swallowed into the stomach. The heart pumps the blood through the body.*
4. What are one difference and one similarity between the human body's reaction to a pathogen and a plant's reaction to herbivory. (10 pts)
*Any one of each:
Difference- Humans produce antibodies, plants produce protease inhibitors. Humans do not signal other humans when they are sick, plants release jasmonic acid to signal other plants.
Similar- Protease inhibitors function against all pathogens like the non-specific immune system.
Volatiles released to attract wasps are specific for one caterpillar like the specificity of B-cells.*
5. If in the dendrite end of a neuron the sodium channels and the potassium channels opened at the same time, would neurotransmitters be released? Why or why not? (8 pts)
No, while Na^+ would rush in and K^+ out, no depolarization would occur and no action potential would result, which means that no neurotransmitter would be released. Since the axon Na^+ channels are sensitive to depolarization, without a depolarization, they would not open.
6. Action potentials are normally generated at the dendrite and propagate down the axon away from the cell body. If you experimentally depolarized an axon above the threshold level at a point halfway down the axon, what direction would the action potential move? Why? (8 pts)
Towards both the dendrite AND axon terminus. Since the axon Na^+ channels are sensitive to depolarization, a depolarization in the middle would cause Na^+ channels on both sides, in both directions, to open.
7. You are reviewing a report that in some species of plants there has been an increase in stomata over the last 200 years. You notice that the newer samples were taken from a mountaintop while the older samples were from sea level. Why would where the samples were collected make a difference in stomata density? (8 pts)
Since air is less dense at high altitudes, it is not surprising that the plants growing at high altitude would have more stomata so they can still obtain enough CO_2 for photosynthesis. The differences

observed probably have more to do with the difference in altitude than differences in overall atmospheric CO₂.

8. One of the nuclei in a pollen grain has a mutation. What is the chance that this mutation will be present in the next generation? Explain. (8 pts)

1/3. There are three nuclei in each pollen, and one will fertilize the egg to make the zygote (embryo).

9. Would pollen in style-type self-incompatibility without any self-incompatibility proteins be able to pollinate an egg? Why or why not? (8 pts)

No, the RNase from the style must be inactivated in non-self pollen. Without the SI proteins there is no way to determine self from non-self, and the RNase will remain active, stopping pollen tube growth.

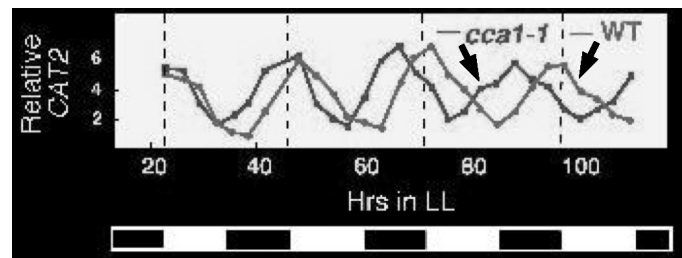
10. You are growing two plants of the same species in direct sunlight, and one of the plants cannot produce phytochrome. One is tall, and the other is short. Which plant lacks phytochrome? Explain. (8 pts)

Tall, active phytochrome changes growth from up growth to out growth. without any phytochrome, the plant is stuck in up growth.

11. Two long-day plants are growing near each other. One receives direct sunlight while the other is growing underneath some other plants. During a period of 16 hours day and 8 hours of night the plant in direct sunlight flowers while the plant in the shade does not flower. Why is the plant in the shade not flowering? (10 pts)

Shade has an overabundance of far-red light. Plants measure night length to determine flowering time, but activating phytochrome can disrupt the night. The plant in direct sunlight is "seeing" a short night, but the plant in the shade is "seeing" a long night.

12. a) What is being measured on the Y-axis (vertical axis), and why were the researchers measuring this? (4 pts)



The amount of CAT2 mRNA, a photosynthetic protein (protein levels is also an acceptable answer). They are looking for how eliminating CCA1 affects the circadian pattern of CAT2 (or photosynthetic genes in general).

b) These plants are in constant light. If the cca1-1 plants were placed in a 12 hour light/12 hour dark cycle, what would the pattern in the cca1-1 plants look like? (4 pts)

Exactly like wild-type.

Bonus: You want to ensure that no one can mate your genetically modified *Brassica* plants with each other to make more plants. How could you accomplish this? Be specific, not about the technique, but about the mechanism that would stop people from breeding your plants to each other. (3 pts)

Make sure that all of your plants have exactly the same SI proteins. Then none of them will reproduce with each other due to SI in Brassica.