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QUESTION 1

As a result of substance abuse throughout adolescence, a young adult suffers from a number of psychological symptoms reflecting diminished executive functioning. Which of the following are likely true of this patient?

I. Pathological changes to the prefrontal cortex.

II. Increased susceptibility to auditory hallucinations.

III.

Reduced behavioral impulse control.

A.

I only

B.

III only

C.

I and III only

D.

II and III only

Correct Answer: C

Executive functioning, or the ability to formulate and stick to long term plans, exercise judgment and impulse control with respect to those plans, is controlled primarily by the prefrontal cortex. In a patient with diminished executive functioning, both (I) and (III) would likely be seen. Thus, (C) is the right answer.

II: The prefrontal cortex is not part of the auditory processing pathway. Thus, there is no reason why a patient with diminished executive functioning would likely have auditory hallucinations.

QUESTION 2

Agonistic behavior, or aggression, is exhibited by most of the more than three million species of animals on this planet. Animal behaviorists still disagree on a comprehensive definition of the term, but aggressive behavior can be loosely described as any action that harms an adversary or compels it to retreat. Aggression may serve many purposes, such as food gathering, establishing territory, and enforcing social hierarchy. In a general Darwinian sense, however, the purpose of aggressive behavior is to increase the individual animal\\'s -- and thus, the species\\' -- chance of survival. Aggressive behavior may be directed at animals of other species, or it may be conspecific -- that is, directed at members of an animal\\'s own species. One of the most common examples of conspecific aggression occurs in the establishment and maintenance of social hierarchies. In a hierarchy, social dominance is usually established according to physical superiority; the classic example is that of a pecking order among domestic fowl. The dominance hierarchy may be viewed as a means of social control that reduces the incidence of attack within a group. Once established, the hierarchy is rarely threatened by disputes because the inferior animal immediately submits when confronted by a superior. Two basic types of aggressive behavior are common to most species: attack and defensive threat. Each type involves a particular pattern of physiological and behavioral responses, which tends not to vary regardless of the

stimulus that provokes it. For example, the pattern of attack behavior in cats involves a series of movements, such as stalking, biting, seizing with the forepaws and scratching with the hind legs, that changes very little regardless of the stimulus -- that is, regardless of who or what the cat is attacking. The cat\\'s defensive threat response offers another set of closely linked physiological and behavioral patterns. The cardiovascular system begins to pump blood at a faster rate, in preparation for sudden physical activity. The eyes narrow and the ears flatten against the side of the cat\\'s head for protection, and other vulnerable areas of the body such as the stomach and throat are similarly contracted. Growling or hissing noises and erect fur also signal defensive threat. As with the attack response, this pattern of responses is generated with little variation regardless of the nature of the stimulus. Are these aggressive patterns of attack and defensive threat innate, genetically programmed, or are they learned? The answer seems to be a combination of both. A mouse is helpless at birth, but by its 12th day of life can assume a defensive threat position by backing up on its hind legs. By the time it is one month old, the mouse begins to exhibit the attack response. Nonetheless, copious evidence suggests that animals learn and practice aggressive behavior; one need look no further than the sight of a kitten playing with a ball of string. All the elements of attack -- stalking, pouncing, biting and shaking -- are part of the game which prepares the kitten for more serious situations later in life.

Based on the information in the passage about agonistic behavior, it is reasonable to conclude that:

I. the purpose of agonistic behavior is to help insure the survival of the species.

II. agonistic behavior is both innate and learned.

III.

conspecific aggression is more frequent than interspecies aggression.

A.

I only

B.

II only

C.

I and II only

D.

I, II and III

Correct Answer: C

The entire passage is about agonistic, or aggressive, behavior, so you need to rely on your memory of the topics of different paragraphs if you want to go back and verify the statements in this Roman Numeral question. Statement I is taken practically verbatim from the final sentence of Paragraph 1. Since the statement is true, you can eliminate Choice B. Statement II paraphrases the entire final paragraph, so it is true as well and Choice A has to be ruled out. Statement III, on the other hand, is not supported by anything in the passage; all you know from the second paragraph is that both conspecific and interspecies aggression exist. Choice C is the correct answer.

QUESTION 3

Alleles are created when a single gene undergoes several distinct mutations. These alleles may have different dominance relationships with one another; for example, there are three alleles coding for the human blood groups, the IA, IB, and i alleles. Both the IA and IB alleles are dominant to the i allele, but IA and IB are codominant to each other.

A multiple-allele system has recently been discovered in the determination of hair coloring in a species of wild rat. The rats are found to have one of three colors: brown, red, or white. Let B = the gene for brown hair; b = the gene for red hair; and w = the gene for white hair. The results from nine experimental crosses are shown below. The males and females in Crosses 1, 2, and 3 are all homozygous for hair color.

Cross	Male	Female	Offspring
1	brown	red	all brown
2	brown	white	all brown
3	red	white	all red
4	brown	brown	3 brown : 1 red
5	brown	brown	all brown
6	red	red	all red
7	red	red	3 red : 1 white
8	brown	red	2 brown : 1 red : 1 white
9	brown	red	1 brown : 1 red

If a large number of brown offspring from Cross 8 are mated with each other, what is the expected percentage of white offspring?

A. 6.25%

B. 8.33%

C. 12.5%

D. 25%

Correct Answer: A

Cross 8 is between a brown male and a red female. The fact that 25% of their offspring are white indicates that both parents are heterozygotes, since white fur is a recessive trait. This means that the genotype of the brown male must be big B, w, and the genotype of the red female must be little b, w. Now we need to figure out the genotypes of the brown offspring. A cross between this brown male and red female results in 25% ww offspring, which are white; 25% little b, w, which are red; 25% big B, w, which are brown; and 25% big B, little b, which are brown. So there are two different brown genotypes in the offspring -- big B, little b and big B, w. If a large number of these brown offspring are mated with each other there are four different crosses possible, and you might want to write them down to avoid confusion; (1) big B, little b ?big B, little b; (2) big B, w ?big B, w; (3) big B, little b ?big B, w; and don\\'t forget (4) big B, w ?big B, little b -- because this is the second way that the third cross can occur. Now we need to figure out what percentage of the offspring produced in these crosses will have white fur. Well, if we work out the Punnett squares, we find that neither the first, the third, nor the fourth crosses yield any white rats. On the other hand, the second cross, big B, w ?big B, w, yields 25% white offspring. But you\\'re not through yet; 25% is not your answer. You have to take into account that only one fourth of the total number of possible crosses between two brown rats yields 25% white offspring. Well, one fourth of 25% is 6.25%, which is the correct answer, choice A.

QUESTION 4

The simple harmonic motion of a mass suspended from vertical springs is investigated in two experiments. The springs used in both experiments have a spring constant k and a natural length L0. The material used to make the springs has a

Young\\'s modulus of 2 x 1011 Pa.

In the first experiment a mass m is suspended from a spring. The mass stretches the spring to a new length L, called the equilibrium length.

In the second experiment the mass m is suspended from two identical springs as shown in Figure 2 below. When the mass m is in equilibrium, each spring is stretched from its natural length by the same amount xe.

In both experiments the masses of the springs are negligible, and the elastic limits of the springs are never exceeded.

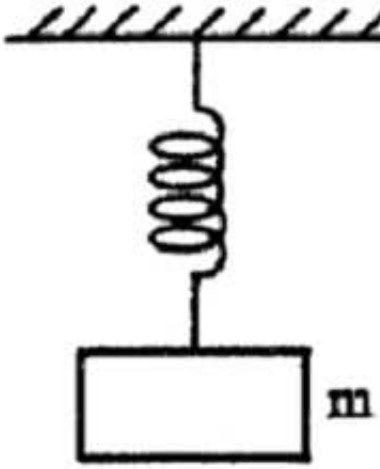

Figure 1

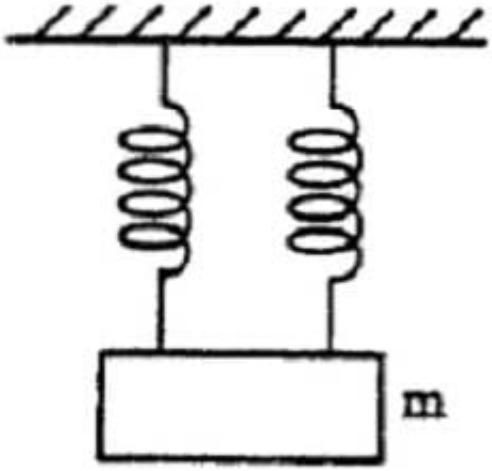

Figure 2

The mass in the first experiment is pulled down a distance A from its equilibrium position and then released from rest. The mass will then oscillate with simple harmonic motion. As the mass moves up and down, energy is dissipated due to factors such as air resistance and internal heating of the spring. The mass will no longer oscillate when the total energy dissipated equals:

A. kL2/2

B. kA2/2

C. k(L + A)2/2

D. kL0 2/2

Correct Answer: B

QUESTION 5

Aerobic respiration is the major process used by oxygen- requiring organisms to generate energy. During respiration, glucose is metabolized to generate chemical energy in the form of ATP: The biochemical machinery necessary for cellular respiration is found in the mitochondria, small organelles scattered throughout the cytoplasm of most eukaryotic cells. The number of mitochondria per cell varies by tissue type and cell function.

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + 36ATP$$

Mitochondria are unusual in that they have their own genetic systems that are entirely separate from the cell\\'s genetic material. However, mitochondrial replication is still dependent upon the cell\\'s nuclear DNA to encode essential proteins required for replication. Despite this fact, mitochondria seem to replicate randomly, out of phase with both the cell cycle and other mitochondria.

The nature of the mitochondrial genome and protein synthesizing machinery has led many researchers to postulate that mitochondria may have arisen as the result of the ingestion of a bacterium by a primitive cell millions of years ago. It is postulated that the two may have entered into a symbiotic relationship and eventually became dependent on each another; the cell sustained the bacterium, while the bacterium provided energy for the cell. Gradually, the two evolved into the present-day eukaryotic cell, with the mitochondrion retaining some of its own DNA. This is known as the endosymbiotic hypothesis. Because mitochondrial DNA is inherited in a non-Mendelian fashion (mitochondria are inherited from the maternal parent, who supplies most of the cytoplasm to the fertilized egg), it has been used to look at evolutionary relationships among different organisms.

Which of the following mitochondrial genome characteristics differs most from the characteristics of the nuclear genome?

A. Mitochondrial DNA is a double-helix.

B. Some mitochondrial genes code for tRNA.

C. Specific mutations to mitochondrial DNA can be lethal to the organism.

D. Almost every base in mitochondrial DNA codes for a product.

Correct Answer: D

To answer this question, you are supposed to pick the characteristic of the mitochondrial genome that differs most from characteristics of the nuclear genome. Now since you probably don\\'t know a lot of information about the mitochondrial genome, and there is little information about it in the passage, let\\'s approach this problem from a slightly different perspective. You do know a lot about the characteristics of the nuclear genome from your introductory biology class. So let\\'s look over the answer choices and find the one that is not a characteristic of the nuclear genome; and this will be our right answer. The nuclear genome is comprised of double-helical DNA that codes for mRNA, tRNA, and rRNA. Therefore, choices A and B are characteristics of the nuclear genome and are therefore incorrect. If a mutation occurred in the nuclear genome that rendered an essential gene non-functional, such as an enzyme involved in glycolysis, the organism would die. Thus, choice C is also a characteristic of the nuclear genome and an incorrect choice. Although the nuclear genome encodes many products, most of the bases of DNA are NON- CODING. That is, they are involved in the regulation of gene expression and do not themselves code for any product. Therefore, choice D is not consistent with the nuclear genome, so choice D is the correct answer. The mitochondrial genome is so small, compared to that of the nucleus, that almost every nitrogen base has to code for a product, the mitochondrial genome doesn\\'t have any DNA to waste!

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