GRE*

Biology Subject Test Practice Test Explanations

KAPLAN

TEST PREP AND ADMISSIONS

Answers and Explanations

ANSWER KEY

1. C
2. C
3. A
4. D
5. E
6. D
7. E
8. B
9. C
10. A
11. A
12. E
13. E
14. B
15. C
16. B
17. C
18. B
19. C
20. A

BIOLOGY EXPLANATIONS

1. (C)

If the frequency of the dominant allele is three times that of the recessive allele, then $p = 3q$. According to Hardy-Weinberg equilibrium, $p + q = 1$, so $3q + q = 1$. Solving for q, we get $4q = 1$; $q = 0.25$ and $p = 0.75$. Again according to Hardy-Weinberg, the frequency of the heterozygotes is equal to $2pq$. Substituting in our values for p and q, we have the equation $2(0.75)(0.25)$, which equals 0.375 or 37.5%.

2. (C)

Before considering the Punnett square for the offspring, we will determine the phenotype of the parents. A red-eyed fly with red-eyed and sepia-eyed parents must be heterozygous because its sepia-eyed parent can only contribute the recessive sepia allele. If this heterozygous fly is crossed with a homozygous recessive (sepia)-eyed fly, half of the offspring will be red-eyed because they will receive the red, dominant allele from the heterozygous fly. The Punnett square will look like this:

		Red-eyed parent	
		R	r
Sepia-eyed parent	r	Rr (red)	rr (sepia)
	r	Rr (red)	rr (sepia)

3. (A)

Nucleotides are made up of a nitrogenous base, guanine, uracil, adenine, cytosine, or thymine; a sugar, either ribose or deoxyribose; and a phosphate group. Adenine and guanine are purines, while thymine, cytosine, and uracil are pyrimidines. Answer choice **(B)** is incorrect because a nucleoside does not contain the phosphate group, just the nitrogenous base and the sugar. Answer choice **(C)** is incorrect because carbohydrates are only sugars, while answer choice **(D)** is incorrect because fats are made up of glycerols and fatty acids. Answer choice **(E)** is incorrect because proteins are only linked amino acids and do not contain anything found in a nucleotide.

4. (D)

ACh is inactivated in the synaptic cleft by the enzyme acetylcholinesterase after it has acted upon the postsynaptic membrane. If chemical *Y* denatures acetylcholinesterase, it will not be able to inactivate acetylcholine and prevent the continuous depolarization of the effector membrane.

5. (E)

This statement is correct. Natural selection is the process by which mutations are "tried out" in the environment and if they offer some degree of fitness, they will be passed on to the next generation. Answer choice **(A)**, Lamarck's theory, was if something was used, such as a giraffe stretching its neck until it became longer, these acquired traits would be passed on to the next generation. We know, however, that acquired characteristics do not affect the genes, and are therefore not passed on to the next generation. Answer choice **(B)** is incorrect because Darwin's theory is much more than mutation. It is based on overreproduction, which allows for genetic variation among the offspring. These offspring are then selected on whether their genetic makeup is the most fit, and these fittest organisms will pass on their genes to the next generation. Answer choice **(C)** is incorrect because Darwin believed that man and apes actually evolved from a common ancestor. And answer choice **(D)** is incorrect because natural selection includes selection pressures but also needs a population with genetic variation in order to select the fittest organisms.

6. (D)

The rate constant (k), which appears in the rate law, is a temperature-dependent constant. For a given temperature nothing will change k, so it can have no influence on an enzyme-catalyzed reaction.

We can eliminate choice **(A)** with the understanding that if the substrate concentration increases, the reaction rate will also increase, until you hit a maximum rate (at which point the enzymes become saturated with substrate). Choices **(B)** and **(E)** are incorrect because all enzymes have an optimal

temperature and pH (for most enzymes it is body temperature and plasma pH; 37°C and 7.2 respectively) under which they operate most efficiently. If the temperature or pH is increased or decreased from the optimal point, the reaction rate will decrease. Choice **(C)** is incorrect because an increase in enzyme concentration will cause an increase in reaction rate, so we are left with choice **(D)**.

7. (E)

The lac operon is a set of control and structural genes in E. coli that allow the digestion of lactose. There are three structural genes controlled by an operator found on another part of the genome. In the absence of lactose, a repressor protein is bound to the operator, preventing RNA polymerase from binding to the DNA, thus preventing translation of the structural genes. However, when lactose is present (and glucose is absent), the repressor is removed and RNA polymerase can attach to the promoter, and translation occurs. This is known as an inducible system.

8. (B)

Vaccines consist of attenuated—that is, weakened or inactive bacterial or viral forms. Vaccines are specifically designed to "fool" the body into synthesizing antigens against a particular pathogen, *without* actually causing the disease typically associated with that pathogen. Therefore, choice **(A)** is wrong, because a smallpox vaccine containing vaccinia virus does *not* cause smallpox. The reason vaccinia is used in the smallpox vaccine is that its protein coat contains antigens similar enough to those found on the smallpox virus that they stimulate the proliferation of B lymphocytes that will then produce antibodies specific for both vaccinia virus and smallpox virus. The vaccine recipient is thus protected against a future smallpox infection. This type of acquired immunity is known as active immunity. Active immunity has two phases: first, the B lymphocytes differentiate into either plasma cells or memory cells. The plasma cells immediately start to synthesize antibodies; the memory cells remain inactive, but retain surface receptors specific for the vaccine's antigens. This is known as the primary response. Upon subsequent exposure to the same antigen, such as a second vaccination or an exposure to the infectious agent, these same memory cells elicit a greater and more immediate proliferation of B lymphocytes; and this is known as the secondary response. If you take a look at the graph, you'll see that the curve following the first smallpox vaccination corresponds to the primary response, and the curve following the second smallpox vaccination corresponds to the secondary response. Thus, choice **(B)** is correct. As for choice **(C)**, although the increase in the serum level of smallpox antibody *can* be attributed to the synthesis of smallpox antibodies, they are synthesized by the recipient's B lymphocytes, *not* by vaccinia virus. Being a virus, vaccinia can't synthesize anything but the proteins and nucleic acid it needs to replicate itself, and it can only do that with the use of a host cell's genetic machinery; it certainly can't synthesize antibodies, which are only produced by multicellular organisms. So, choice **(C)** is wrong. And there's no evidence in the question stem to support the claim that the smallpox vaccine or any other vaccine requires a minimum of 45 days to confer active immunity, so choice **(D)** is also wrong. Again, the correct answer is choice **(B)**.

9. (C)

Answering this question correctly is dependent on your knowledge of cyanide. Cyanide is a poison that interferes with the electron transport chain of the inner mitochondrial membrane by binding to one of the electron transfer complexes. In doing so, cyanide completely inhibits the flow of electrons and effectively paralyzes the transport chain. As a consequence, the proton pump comes to a stop, and ATP cannot be generated aerobically. In addition, electron carriers such as NADH and $FADH_2$ can't deliver their high energy electrons to the electron transport chain because it has become backed up. This means that NAD+ and FAD are not regenerated, and aerobic respiration can't continue. Getting back to the question, energy is required for a bacteriophage, or any organism for that matter, to replicate. DNA replication, RNA transcription, and protein synthesis all require ATP and are processes necessary for viral replication, as well as for host cell function. If aerobic ATP formation is inhibited, there will not be enough ATP for normal cell functions *or* for viral replication. Therefore the correct answer is choice. Choices **(A)**, **(B)**, and **(D)**

are incorrect because they do not correctly describe cyanide's mechanism of action. Again, choice **(C)** is the right answer.

10. (A)

This question tests your knowledge of eukaryotic, prokaryotic, and viral structure. Viruses are composed of a nucleic acid encapsulated by a protein coat—period. Bacteriophage are viruses that infect bacteria only. Since the answer to the question is an organism characterized by the presence of a cell wall, you can rule out choice **(B)**, bacteriophage, and choice **(C)**, viruses, which leaves you with only two choices. Choice **(D)**, fungi, are eukaryotic, heterotrophic organisms, and as such, have membrane-bound organelles. Fungi do have cell walls, which are composed of chitin, but they also have nuclei bound by nuclear membranes, so choice **(D)** is also wrong. Which leaves us with choice **(A)**, bacteria. Bacteria are members of the kingdom Monera—a group of unicellular, primitive, prokaryotic organisms. Prokaryotes are characterized by a lack of membrane-bound organelles. Bacteria typically have a cell wall, a cell membrane, ribosomes, and a circular chromosome located in a region of the cell known as the nucleoid. Therefore, of the answer choices, it is the bacteria that are characterized by the presence of a cell wall but the lack of a nuclear membrane. Again, choice **(A)** is the correct answer.

11. (A)

The names of the specific proteins and genes are not relevant to answering this question. The question is asking: "What mechanism for transporting proteins requires ATP?" Active transport, choice **(A)**, is the net movement of dissolved particles against their concentration gradient using a transport protein. Because the particles are moved against their concentration gradient, this process requires energy in the form of ATP.

12. (E)

Organisms are classified according to evolutionary relationships in the following categories: Kingdom > Phylum > Class > Order > Family > Genus > Species. The largest group (kingdom) is broken down into smaller and smaller subdivisions. Each smaller group has more specific characteristics in common. Of the choices listed, genus is the smallest subdivision, and organisms in the same genus would be more similar than organisms that were only classified in the same kingdom, class, or family. Thus, the correct answer is choice **(E)**.

13. (E)

Enzymes are biological catalysts that increase the rate of a reaction. The rate of an enzyme-catalyzed reaction can be increased by adding more substrate, so statement (1) should be part of the correct answer. Most enzymes are proteins; the ability of a protein enzyme to function is dependent on its three-dimensional structure. A protein's three-dimensional structure may be affected by changes in temperature or pH, so statements (2) and (3) should also be part of the correct answer. Thus, I, II, and III, or choice **(E)**, is correct.

14. (B)

Examples of fungi include mold, yeast, and mushrooms. Fungi are eukaryotic organisms, typically filamentous or, rarely, unicellular. The filamentous forms consist basically of continuous hyphae that form a mycelium; thus choice **(C)** is incorrect since it *is* true of fungi and you're asked to determine which of the choices is *not* true. All fungi have chitin-containing cell walls, as well as plasma membranes. Therefore choice **(B)** must be the correct answer. Choices **(A)** and **(D)** are wrong because they are both true. Fungi reproductive cycles often include both sexual and asexual phases, meaning that haploid and diploid states are both possible. In addition, fungi are heterotrophs that obtain nutrients through absorption. Again, choice **(B)** is the correct answer.

15. (C)

Skeletal muscle has multinucleated fibers with a regular array of actin and myosin filaments. These filaments slide along each other and shorten during contraction. This process requires ATP. Each muscle cell/fiber is innervated by a branch of the nerve innervating this muscle. The axon releases an action potential to each muscle fiber. This action potential cannot pass from one muscle fiber to another. When this action potential reaches the muscle fiber, it causes the release of Ca^{2+} from the

sarcoplasmic reticulum to initiate the sliding of the actin and myosin filaments.

16. (B)

This is a basic outside-knowledge question, though the phrasing of the question might have thrown you off a bit, since it seems to suggest that bacterial strains 1 and 2 may share characteristics that other strains of bacteria lack. However, this isn't true; all you really have to do is identify which of the choices is not found in *any* bacteria. I hope you remembered that bacteria are prokaryotes, and that the main characteristics of prokaryotes are that they have circular DNA, they don't have *any* membrane-bound organelles, they have ribosomes (which are structurally different from eukaryotic ribosomes), and they have cell walls composed of complex macromolecules of amino acids and amino sugars. Thus, choices **(A)**, **(C)**, and **(D)** are structures found in all bacteria, and thus can be eliminated. On the other hand, choice **(B)**, mitochondria, are the membrane-bound organelles that supply eukaryotic cells with ATP, and so choice **(B)** is the correct answer.

17. (C)

Choice **(D)** is the odd man out, so it's worth checking quickly to see if it's correct or not. In fact, chemoautotrophs are organisms that derive their energy from the oxidation of inorganic chemical compounds rather than organic compounds, and require carbon dioxide for growth. There's no reason to believe that this describes Strain 2—in fact, you have reason to believe that it doesn't, since Strain 2 can digest some starches, which are organic molecules. So choice **(D)** is incorrect. As for the other three: according to the results of Experiment 2, Strain 2 exhibited colony growth both on the surface of the agar, which is exposed to oxygen, and within the agar itself, which according to the passage, is oxygen-poor. To figure out whether this fits choices **(A)**, **(B)**, or **(C)**, you have to know or figure out what these terms mean. An obligate anaerobe is an organism that obtains its energy via anaerobic processes such as fermentation. Since oxygen is a highly reactive compound, and since anaerobes don't consume oxygen in metabolism, oxygen tends to be toxic to anaerobic organisms. Thus, an obligate anaerobe would not be expected to grow on the surface of an agar plate. Since Strain 2 did exhibit growth under these conditions, choice **(A)** is incorrect. Obligate aerobes, choice **(B)**, are organisms that require oxygen for metabolism, which implies that such an organism would *not* exhibit growth within an oxygen-poor environment such as the inside of the agar layer in Experiment 2. Thus, choice **(B)** is also incorrect. This leaves us with choice **(C)**, facultative anaerobes. A facultative anaerobe is an organism that normally derives its energy aerobically, but also has metabolic pathways that allow it to exist under anaerobic conditions, such as within the layer of agar. Since this definition corresponds to the results of Experiment 2, Strain 2 bacteria would most likely be classified as facultative anaerobes, and so choice **(C)** is the correct answer.

18. (B)

The results of Experiment 1 for Strain 1 indicate that Strain 1 is capable of growing on al three of the starch-agar plates used in the protocol, though iodine staining revealed that, at least for the first 48 hours of growth, Strain 1 does not digest Starch *A*, *B*, or *C*. In other words, although starch digestion is absent during the first 48 hours, colony growth occurs. This implies that Strain 1 bacteria must not use starch for its first 48 hours of growth, and so choice **(B)** must be correct. Let's look at the other answer choices. Choice **(A)**, which says that Strain 1 bacteria do not possess the enzymes necessary for starch digestion, is a tempting choice, since you know that starch digestion doesn't occur in the course of the experiment. However, as you should know, metabolic pathways are not necessarily active at all times, and it's quite common for a bacterium to use one nutrient source preferentially over another and only to switch to a second source, and the pathways required to utilize it, after the first, more attractive nutrient has been exhausted. So, although it might be the case that the strain doesn't possess a starch digestion pathway, as a researcher, you would not be justified in drawing this conclusion after only 48 hours of incubation time; it could just be that the starch pathway is there but just isn't activated within 48 hours, because there are enough other nutrients present to keep the cells alive for that time. In order to conclusively demonstrate that Strain 1 lacks the enzymatic

machinery to digest starch, you would want to repeat Experiment 1 with a longer incubation time. Thus, choice **(A)** can be eliminated. As for the remaining choices: choice **(C)** says that Strain 1 bacteria grow best in an oxygenated environment. Well, while this claim was actually substantiated by the results of Experiment 2, this conclusion can't be drawn from Experiment 1, because plates *A*, *B*, and *C* are only examined for growth on the agar surface, not within the agar layer; thus, choice **(C)** is incorrect. Finally, choice **(D)** is incorrect because not only is it false that Strain 1 bacteria can't grow on starch-agar medium *C*—because they do—but even if it were true, this alone would not be enough to account for the discrepancy between starch digestion and colony growth, which is the issue that this question is actually addressing. Again, choice **(B)** is the correct answer.

19. (C)

This question is related to question 17, in that repeating Experiment 1 with an incubation time of five days—120 hours—rather than 48 hours, you're investigating the mystery of how Strain 1 bacteria can grow on starch-agar media for 48 hours without actually digesting any of the starch. You're told that when the researcher repeated Experiment 1, the results were identical to those described in the passage, except that Strain 1 bacteria now exhibited starch digestion on all three of the starch-agar plates. So, you're asked to decide what conclusions might be drawn from this new data. Statement (1) says that Strain 1 bacteria require longer incubation times to digest starch. Well, based on the data, this conclusion does follow: with an incubation period of 120 hours, not only did Strain 1 grow on all three media—which we'd already seen from the original experiment 1—but it also digested all three types of starch. Thus, statement (1) is correct, so choice **(B)**, III only, can be eliminated. Statement (2) says Strain 2 needs oxygen for its early stages of development. This is clearly incorrect, because Experiment 1 did not address the oxygen metabolism of the bacterial strains—this was only tested in Experiment II. And actually, if you check Table 2, Strain 2 grows in the oxygen-poor environment below the agar surface, so it doesn't need oxygen to grow. Thus, Statement (2) is false, and so choice **(D)**, which includes that statement can also be ruled out. Finally, statement (3) says that Strain 2 cannot grow on starch-agar medium *C*. Based on this, it is fairly safe to assume that if Strain 2 has not started to grow after this length of time, then it won't grow at all. Thus, Statement (3) is a valid conclusion, which means that choice **(A)** is wrong and choice **(C)** is the right answer.

20. (A)

In this version of the experiments, Strain 2 exhibited starch digestion on all three of the starch-agar media, whereas in the first run of the experiments, Strain 2 digested only two out of the three different starches—it didn't digest Starch *C*. Well, this means that between the first and second trials, something happened to some of the bacteria in Strain 2 that now allowed them to digest Starch *C*. So now you need to look at the answer choices to determine which of the processes would most likely account for these new observations. Mutation, choice **(A)**, is a change in DNA sequence; though most mutations are deleterious to an organism, mutations, sometimes they have beneficial results. An example of this would be if a mutation made Strain 2 able to digest Starch *C* in the second trial of Experiment 1, since this ability would increase the bacteria's survival ability. A mutation that resulted in the synthesis of an enzyme capable of digesting Starch *C* could plausibly explain the observed results. Thus, choice **(A)** is the correct answer. Transduction, choice **(B)**, is the transfer of bacterial DNA between two bacteria via a bacteriophage, which is a type of virus that only infects bacteria. Though transformation could account for Strain 2's newfound ability to digest Starch *C*, since the introduction of new DNA might provide the bacteria with some enzymes of metabolic pathways that it previously lacked, this is not the *most likely* explanation in this case, because there's no evidence of bacteriophage infection in the bacterial strains. Furthermore there's no bacterial strain around that can digest starch *C* from which the capacity could be transformed. So, choice **(B)** is wrong. Choice **(C)**, nondisjunction, is the failure of paired chromosomes or chromatids to properly separate during mitosis or meiosis, resulting in daughter cells that either lack a chromosome, or have triplicate copies of one. Since bacteria don't have separate chromosomes but just one piece of

circular DNA, nondisjunction can't possibly occur during bacterial DNA replication. And, even if the chromosome failed to replicate correctly, this wouldn't produce any new DNA, so it couldn't possibly give the bacteria a new metabolic pathway; thus choice **(C)** is wrong. Finally, choice **(D)** is wrong because meiosis is the eukaryotic process by which gametes are formed. Prokaryotic organisms do not undergo meiosis at any stage of their existence; they replicate via binary fission, which is basically mitosis. Again, choice **(A)** is the correct answer.

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