Topic 5: Molecular Genetics

Level 1

1. B
2. D
3. C
4. D
5. B
6. A
7. B
8. B
9. C
10. C
11. D
12. A
13. B
14. B

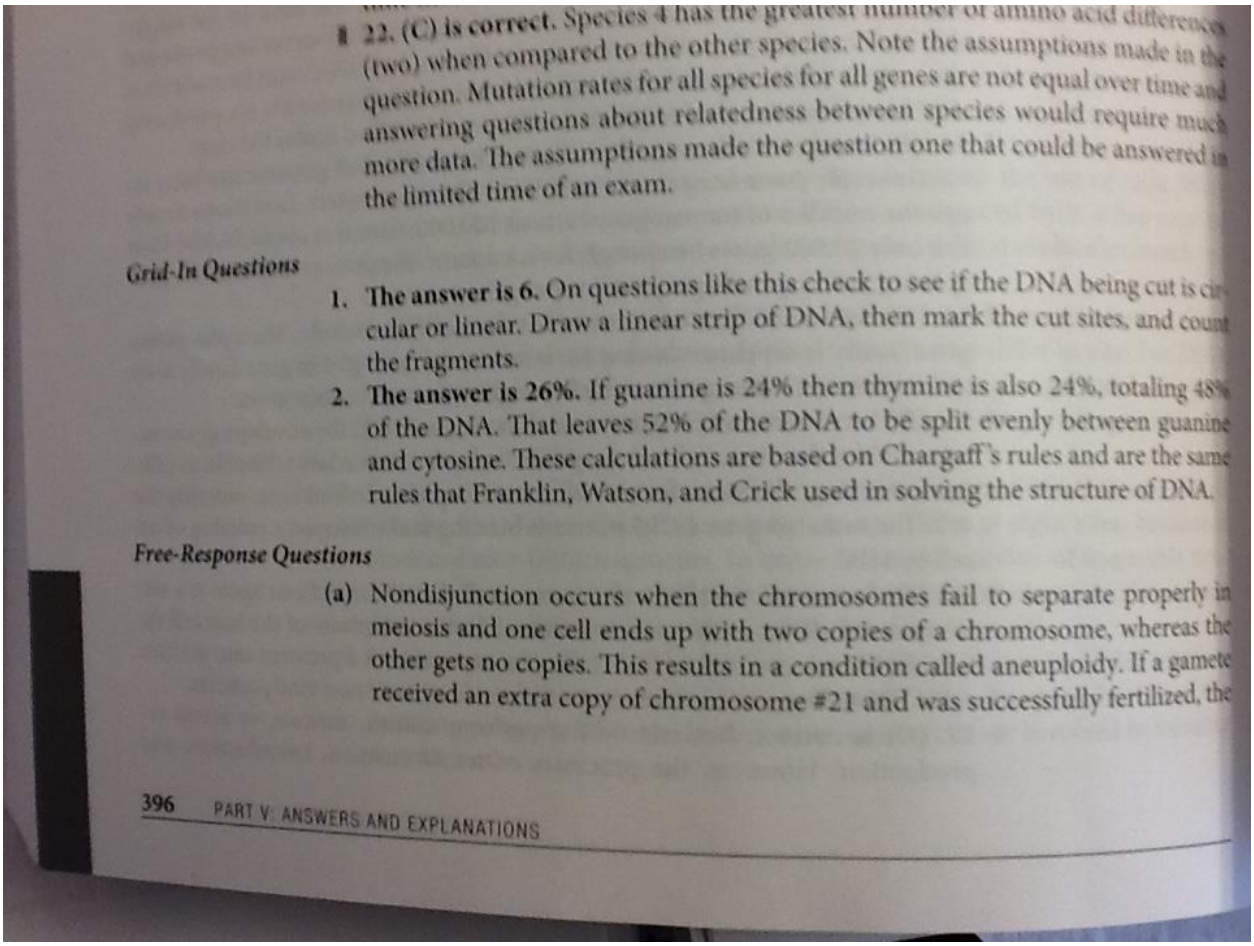
Level 2

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

GRID IN

1. 6
2. 26%

FRQ



22. (C) **is correct.** Species 4 has the greatest number of amino acid differences (two) when compared to the other species. Note the assumptions made in the question. Mutation rates for all species for all genes are not equal over time and answering questions about relatedness between species would require much more data. The assumptions made the question one that could be answered in the limited time of an exam.

Grid-In Questions

1. **The answer is 6.** On questions like this check to see if the DNA being cut is circular or linear. Draw a linear strip of DNA, then mark the cut sites, and count the fragments.
2. **The answer is 26%.** If guanine is 24% then thymine is also 24%, totaling 48% of the DNA. That leaves 52% of the DNA to be split evenly between guanine and cytosine. These calculations are based on Chargaff's rules and are the same rules that Franklin, Watson, and Crick used in solving the structure of DNA.

Free-Response Questions

(a) Nondisjunction occurs when the chromosomes fail to separate properly in meiosis and one cell ends up with two copies of a chromosome, whereas the other gets no copies. This results in a condition called aneuploidy. If a gamete received an extra copy of chromosome #21 and was successfully fertilized, the

LAB: BACTERIAL TRANSFORMATION

1. B
2. D
3. D
4. C

LAB: RESTRICTION ENZYME ANALYSIS

1. D
2. B
3. C
4. C

child would exhibit Trisomy 21, which is characterized by mental retardation and reduced stature.

A base-pair deletion can occur when a DNA copying error results in the loss of a single nucleotide, and a frameshift means that the triplets being read will all be different. If this occurs within an intron there will be no phenotypic effect because introns are removed prior to translation.

A base-pair substitution results when one nucleotide, such as thymine, is substituted for another, such as guanine. This type of error occurs to cause sickle-cell disease. When a different amino acid is placed into the polypeptide, it can affect the secondary or tertiary structure of the protein so that it does not fold into the correct conformation. Change the shape, change the function. If it is an enzyme or other protein, it may no longer function as it did.

(b) Colorblindness is more common in males than females because males are hemizygous for these traits. The trait is found on the X chromosome, and because males have only one copy of the X chromosome, they will show the phenotype for whatever allele they receive. Females, on the other hand, have two copies of the X chromosome and, if one X chromosome has an allele for colorblindness and the other X chromosome carries an allele for normal vision, the female will have normal vision. She is a "carrier" for colorblindness because she can pass it on to her sons.

(c) When fertilization occurs and a sperm carrying a Y chromosome penetrates the egg first, a male zygote with one X and one Y chromosome is produced. If a sperm carrying an X chromosome penetrates the egg first, a female zygote with XX is produced. Although it seems as though the female zygote would have twice the cell product as the male, due to its double dose of genes located on the two X chromosomes, this is not the case. The reason for this is that, in every cell of the female human body, one of the X chromosomes is inactivated. The mechanisms for this are not fully understood, but the X chromosome that is inactivated condenses into a structure called a Barr body, which then associates with the nuclear envelope. This is called X-inactivation, and the condensed DNA is heterochromatin. As a Barr body, most of the X chromosome's genes are not expressed. As a result of this, females are a mosaic consisting of cells with the X chromosome from their mother activated and other cells with the X chromosome from their father activated in about a 50:50 ratio. This is also the reason sex-linked disorders are usually not expressed in females. Although one of the X chromosomes may be incapable of producing a crucial gene product, this mosaic effect ensures that the other half of the somatic cells produces sufficient amounts of the protein in question.

Note that the response for part (c) covers more than the question asks. The graded response does not actually begin until the fourth sentence. Also, the last two sentences go beyond the question. Because your time is limited, always focus on JUST the question.