DESIGNER GENES ANSWER KEY FINAL

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One point per question. First tiebreakers are in order and highlighted.

STATION 1: Nucleic acids

1) adenine
2) guanine
3) phosphate
4) deoxyribose
5) DNA
6) 2
7) 3
8) 200 micrograms per milliliter
9) C
10) A
11) E
12) Usually, %A=%T and %C=%G
13) The virus's genetic information is single-stranded DNA.
14) C
15) D
16) B
17) The fifth generation!
18) In the 0^{th} generation, 100% of the cells have both strands radioactive for each chromosome.
In the 1^{st} generation, each piece of DNA has one radioactive strand, so all cells are still radioactive.
In the second generation, there are two with the original radioactive cells and two without, so 50% are radioactive.
In the third, there are still two cells with original radioactive DNA of 8 total, so only 25% are radioactive at this point.
In the fourth, there are two cells out of 16 = 12.5% of cells are radioactive.
The fifth generation gives us two cells out of 32, breaking the 90% barrier for non-radioactive chromosomes.
Pictures also appropriate with clear explanation.

STATION 2: Gene expression

1) 100%, 50%, 10%, 5% OR 100, 50, 10, 10

2) Loading control. Helps make sure we started with the same amount of cellular material.

3) Gene E is repressed about 50% in the presence of the growth factor.

OR

You see the loading controls and comment that there's not enough information, which is more accurate.

Must reference appropriate lanes and give reasoning.

4) Requires protein production in the cell to be transcribed; perhaps a transcription factor.

5) D

6) Each spot in a codon can have one of four bases, and there are four spots in this hypothetical codon. One is subtracted for a stop codon.

7) A

8) Transducing phage pick up sequential chunks of bacterial genome. If the genes are very far away, it is unlikely that more than one will be packaged into one phage.

9) B

10) Point mutation from Lys to Asn; all others remain unchanged.

11) Many subsequent amino acids would be changed.

12) No. The final mRNA contains only exons with introns removed.

13) B

14) C

15) B

16) D

17) B

18) A

STATION 3: Modern lab techniques

1) D
2) western blotting: run protein samples out to separate by size, then probe to see pieces of protein that have a specific sequence
3) northern blotting: run mRNA samples out to separate by size, then probe to see pieces of mRNA that have a specific sequence
4) *in situ* hybridization: use labeled nucleotide probe to see where desired mRNA is located in an animal or embryo
5) polymerase chain reaction: make many copies of one specific DNA fragment
6) electroporation: using electric shock to make cell membranes temporarily permeable
7) #4, or in situ hybridization
8) C
9) C
10) each restriction enzyme is specific for a given sequence, but it might be in different places on different pieces of DNA OR electrical charge sorts by mass/size OR all pieces are negatively charged, so they run in the same direction
11) DNA primer – provides a 3' hydroxyl for the polymerization reaction OR
Thermostable DNA polymerase – enzyme to catalyze extension OR
DNA template – the thing we want to amplify OR
dNTPs – nucleotides used in the reaction OR
Buffer – keeps the reaction conditions constant over the long time
12) See question #11
13) B
14) The first step at 95 ensures that the DNA strands are melted. The second step at 55 is meant to ensure that the template can anneal to the appropriate complementary sequence with specificity. Lastly, 70 is the optimal temperature for the thermal-stable DNA polymerase to work.
15) 2 and 3
16) 3
17) Marker genes are selected because they are easy to verify/detect if successfully transferred, so scientists use them to verify that the organism under study has absorbed the genetic material.
18) Her telomeres were as short as a six-year-old sheep soon after she was born. She died after six years (the usual life span is 12ish).

STATION 4: Heredity

1) B
2) II and III
3) Neither of these parents has a functional copy of the photoreceptor to give. The child might be adopted, or have another father, or there was a spontaneous mutation during DNA replication in meiosis or early in development that resulted in a "repaired" gene. X inactivation for the woman also acceptable as an idea for this question as long as it is explained that the inactivation would have happened in the progenitor cells of the eye.
4) **E**
5) Autosomal dominant. Roughly half of the offspring of affected persons are themselves affected, every affected person has an affected parent, and X linkage is ruled out by male to male transmission. Three carriers would have needed to marry into the family, but the disorder is rare, so that's very unlikely.
6) Female: no x chromosome
7) A nondisjunction event during meiosis that produced either mom or dad's sex cell.
8) On average, 1 out of 4 offspring of heterozygous parents will be homozygous recessive.
9) Differential survival and reproduction. Must reference mechanism of natural selection/evolution to get credit.
10) A
11) DNA
    OR
    RNA with proper reverse transcription
12) One nucleotide changes.
13) One amino acid changes.
14) The protein might stop early, or it might be a different shape as a result of the mutation. Both might affect its function in the cell.
15) No: only in the germline, or sex cells and their forebearers, would this mutation cause a problem.
16) conjugation, transformation, transduction
17) transformation, transduction
18) transduction

STATION 5: Miscellaneous molecular biology!

1) E
2) The centromere is where chromosomes attach to the mitotic spindle, so dicentric chromosomes can be simultaneously pulled to opposing poles during cell division.
3) B
4) Reverse transcriptase makes DNA from RNA, which is not needed here.
5) A
6) A
7) *Genlisea margaretae* has a genome size of 6E7. Credit given for 6E6 to 6E8.
8) *Paris japonica* has a size of 1.5E11. Credit given for 1.5E10 to 1.5E12.
9) A
10) 1%. This is a probability problem.
11) Incomplete dominance
12) A blend of phenotypes, like the famous red-and-white-flowering makes pink-flowering example.
13) Codominance
14) Like the roan cow, both phenotypes are present. Another example where both phenotypes are present is in AB blood type.
15) Plasmid, BAC, YAC
16) FISH finds certain regions on chromosomes using fluorescent DNA probes. FISH analysis can find small pieces of chromosomes that are missing or have extra copies. These small changes can be missed by the overall karyotype test.
17) 95%. 90% to 100% given credit.
18) Ss

QUESTION AND INFORMATION SOURCES:

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http://scioly.org/wiki/images/8/85/2006_polyregional_Exam.pdf
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