

DESIGNER GENES * SOUTHERN POLY REGIONAL 2006

1. A true-breeding plant with yellow seed is crossed to a true-breeding plant with green seeds. All of the F1s are yellow. The F1s are allowed to self. What fraction of the F2s will be true breeding?
 - A. $1/4$
 - B. 2
 - C. $3/4$
 - D. $4/4$
2. What fraction of the yellow F2 from the above cross will be true-breeding?
 - A. $1/4$
 - B. $1/3$
 - C. 2
 - D. $2/3$
3. Which of the following is true of a recessive trait?
 - A. It requires two identical alleles for expression.
 - B. It requires either 1 or 2 alleles for expression
 - C. It is usually present in every generation
 - D. It can only occur if both parents also show the trait.
4. Two brown cows are mated. The calf is white. Which of the following statements best describes this situation?
 - A. Brown is dominant, and the next calf has a $3/4$ chance of being white.
 - B. Brown is dominant and the next calf has a $1/4$ chance of being white.
 - C. White is dominant, and the next calf has a $3/4$ of being white.
 - D. White is dominant and the next calf has a $3/4$ chance of being brown.
5. All of the following are true of mitosis EXCEPT
 - A. DNA duplication occurs during the early stages of mitosis.
 - B. Cells with identical genetic composition are produced.
 - C. Two cells are produced.
 - D. Pairing of homologous chromosomes does not occur.
6. What does it mean to say that a gene is located on human chromosome 8 q?
 - A. It is located on the long arm of chromosome 8.
 - B. It is located on the short arm of chromosome 8
 - C. It is located in the 8th band that is stained with quinacrine.
 - D. It is located on the 8th q band.
7. A diploid organism has 18 chromosomes in its somatic cells. How many chromosomes are expected in cells after the first meiotic division?
 - A. 6
 - B. 9
 - C. 18
 - D. 36

8. For there to be no evolution within a population, all of the following must occur EXCEPT
- no mutation
 - large population
 - migration
 - random mating
9. A population has 49 AA individuals, 42 Aa individuals, and 9 aa individuals. What are the allele frequencies?
- $p = 0.91$ and $q = 0.09$
 - $p = 0.75$ and $q = 0.25$
 - $p = 0.7$ and $q = 0.3$
 - $p = 0.5$ and $q = 0.5$
10. In a population thought to be at equilibrium 1 in 10,000 individuals shows the recessive trait. What is the frequency of the recessive allele?
- 0.0001
 - 0.001
 - 0.01
 - 0.1
11. A strand of DNA has the following sequence: 3' T C G G A C G A T C G 5' What is the sequence of the complimentary strand?
- 5' T C G G A C G A T C G 3'
 - 5' A G C C A C C T A G C 3'
 - 5' A G C C T G C T A G C 3'
 - 5' C G A T C G T C C G A 3'
12. A double stranded DNA molecule is 18% T. What per cent of the bases is C?
- 18%
 - 28%
 - 32%
 - 82%
13. White eyes is X-linked recessive and red is X-dom. A true breeding white eyed female is mated to a red eyed male. Which of the following correctly lists the expected F1 progeny?
- All red eyes of both sexes
 - All white eyes of both sexes
 - All red females and all white males
 - All white female and all red males
14. In humans, color blindness is an X-linked recessive trait. A color blind woman and a color blind man have a normal vision son. What is the best explanation for this observation?
- The woman had an affair and the child is not the father's
 - The child can be their child
 - The child is either adapted or was switched at the hospital
- 15-22 Indicate whether each of the following statements is true (T) or false (F).
15. If two normal individuals have three children, each of whom is affected by the same genetic disorder, the probability that their fourth child will also have the disorder is less than 1/10.
16. If two individuals, each with the same dominant trait, mate, all of the children will be expected to have the trait.

17. An X-linked recessive trait will be passed from father to all of his sons.
18. Because females have two X chromosome, X linked traits are more likely to be expressed in females.
19. An X-linked dominant trait will be passed from an affected male to all his daughters.
20. A karyotypic analysis of a developing fetus will reveal if it has a disorder such as Tay-Sachs, cystic fibrosis, or sickle cell anemia.
21. If a population is not in Hardy Weinberg equilibrium, it will achieve equilibrium in the next generation if selection is not occurring.
22. If all the homozygous recessive individuals die each generation, the recessive allele will be completely eliminated within three generations.
23. The double stranded DNA below represents the beginning of a gene that codes for a protein with at least 7 amino acids. Which strand is made into mRNA, and in which direction is the mRNA read by the ribosome?

TAC ATG ATC ATT TCA CGG AAT TTC TAG CAT GTA

ATG TAC TAG TAA AGT GCC TTA AAG ATC GTA CAT

- A. top strand, message read left to right
 - B. top strand, message read right to left
 - C. bottom strand, message read from left to right
 - D. bottom strand, message read from right to left
- 24-25 The next two questions pertain to an RNA molecule with the following sequence:
- AUG CCC AAA* CAG UGC GAG CUU ACG
24. What will be the consequence if the A indicated by * is changed to U?
 - A. One amino acid will be changed
 - B. Many amino acids will be changed.
 - C. The protein will have only 2 amino acids
 - D. The protein will have only 5 amino acids
 25. What will the consequence be if a C is added just prior to the A*?
 - A. Many subsequent amino acids will be changed.
 - B. Only one amino acid will be changed.
 - C. No amino acids will be changed.
 - D. The protein will be shorter than normal.

26. A DNA molecule is 35% guanine. What per cent of the bases is adenine?
- A. 15%
 - B. 35%
 - C. 65%
 - D. 70%
27. An RNA molecule has 150 bases. What is the maximum number of amino acids that could be encoded by this mRNA?
- A. 50
 - B. 100
 - C. 150
 - D. 450
- 28-29 The gene for dystrophin, a muscle protein, is 2.1×10^6 base pairs long.
28. If all these bases were used in the coding sequence, approximately how many amino acids could be coded by this gene?
- A. 7.0×10^5
 - B. 1.4×10^6
 - C. 2.1×10^6
 - D. 6.3×10^6
29. If the rate of transcription is 50 bases/sec, approximately how long will it take the cell to make the RNA for dystrophin?
- A. 12 min
 - B. 1 hr
 - C. 12 hr
 - D. 36 hr
- 30-31 PKU, maple sugar urine disease (MSUD), and cystic fibrosis (CF) are each independent autosomal recessive human disorders.
30. A normal woman whose father had PKU marries a man with PKU. What is the probability that this couple's first child will be normal with regard to PKU?
31. If two normal individuals, but each carriers for the above three disorders, mate, what is the probability that their first child will have PKU and cystic fibrosis, but be normal for MSUD? (2)

32-33 Achondroplasia is a type of dwarfism. Two dwarfs marry and have a dwarf child then a normal child.

32. Is dwarfism dominant or recessive?

33. What is the probability that their next child will be normal?

34. Galactosemia is an autosomal recessive trait. A normal woman whose father had galactosemia marries a normal man whose grandmother had galactosemia. What is the probability that the first child will have galactosemia?

35-37 Pertaining to the following cross: Aa Bb CC Dd Ee X aa Bb cc Dd ee

35. What fraction of the progeny is expected to show all dominant traits?

36. What fraction of the progeny is expected to show all recessive traits?

37. What fraction of the progeny is expected to be heterozygous for all five genes?

38. You cross an individual that is AABB with one that is aabb. The F1s are selfed to produce F2s. What is the probability that the F2 plant will contain one half of its alleles from each grandparent?

39-40 In horses, there are three independent color producing genes. WW is lethal, Ww is white, regardless of what other alleles are present, and ww allows color. OO or Oo is solid, oo has white spots on color. BB or Bb is black, bb is chestnut. Two horses, each heterozygous for all three genes, are mated.

39. What is the phenotype of the heterozygous individuals?

40. Of the LIVING progeny, what fraction is expected to be chestnut with white spots? (2)

41. In squash, white is dominant over yellow and disk shaped is dominant over sphere shaped. Based on the following information, determine the genotypes of the yellow, sphere parent.

	cross parents	progeny
1.	white, disk X yellow sphere:	1/4 white, disk; 1/4 white sphere; 1/4 yellow disk; 1/4 yellow sphere
2.	white, disk X white, sphere:	3/8 white, disk; 3/8 white, sphere; 1/8 yellow, disk; 1/8 yellow, sphere

42-44 In Drosophila, yellow body is an X-linked recessive allele, and brown eyes is an autosomal recessive allele. The respective dominant alleles are tan and red. A true breeding yellow, body, brown eyed male is mated with a true breeding tan bodied, red eyed female.

42. What is (are) the phenotype(s) of the F1 females?

43. What is (are) the phenotype (s) of the F1 males?

44. If the F1s are allowed to mate, what fraction of the F2 females is expected to be yellow body with brown eyes?

45. Color blindness is an X-linked recessive trait in humans. A normal visioned woman whose father was color blind marries a normal visioned man. They have a color blind daughter who has only one X chromosome. In which parent did the sex chromosomes fail to separate?

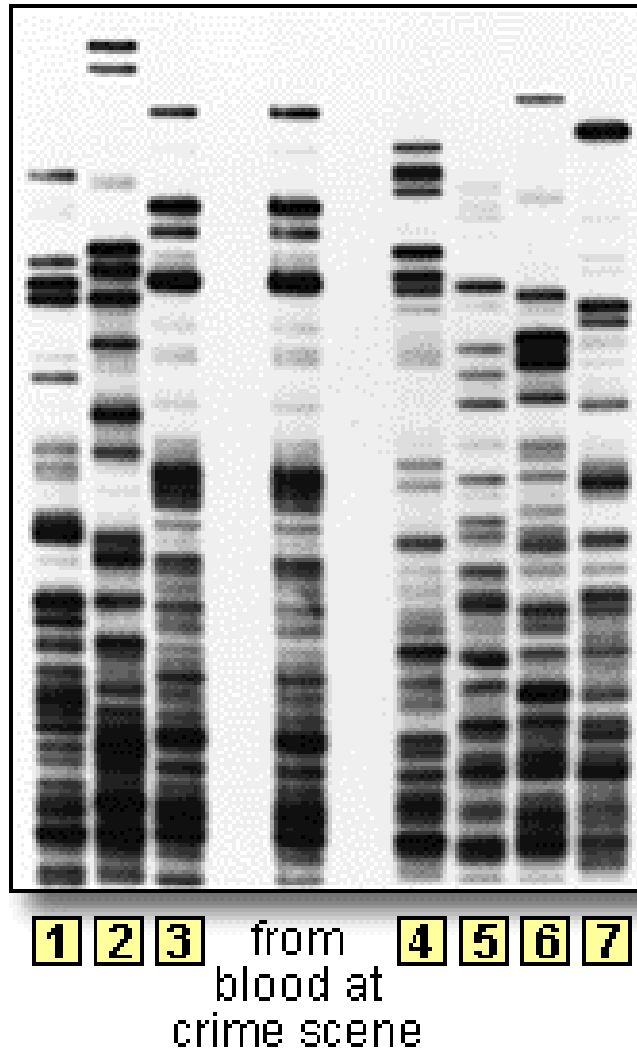
46. The DNA is cut into pieces by a particular kind of enzyme. What kind of enzyme is used?

47. The normal gene for hemoglobin, when digested with a particular restriction enzyme, yields fragments of 2.3, 3.1 and 3.6 kb. When the DNA from people with sickle cell anemia is digested., only fragments of 2.3 and 6.7 kb are seen. Which fragment cannot be in the middle of the normal gene?

- 48-50 Skin cells of an organism have 42 chromosomes. How many chromosomes would you expect to see in
48. Liver cells _____
49. Sperm cells _____
50. Nerve cells _____
51. An individual is heterozygous for 4 different unlinked genes. How many different gametes can this individual produce?
52. In a population of 500, p (frequency of dominant allele) is 0.6, and q (frequency of recessive allele) is 0.4. If the population is in equilibrium, how many individuals do you expect to be heterozygous?
53. Given the following recombination frequencies, determine the order of the genes.
- | | | | |
|-----|------|-----|-----|
| A-B | 8% | B-C | 20% |
| A-C | 28% | B-D | 33% |
| A-D | 25 % | | |
54. The gene for thinkase is isolated and found to be 6.3 kb long. Digestion of this DNA with Eco R1 yields fragments of 4.1 and 2.2 kb; digestion with BamH1 yields 3.0, 2.5, and 0.8 kb; the mix yields 0.8, 1.1, 1.4, and 3.0 kb. A mutant of the gene is isolated and then digested with BamH1 to yield fragments of 5.5 and 0.8 kb. Where is the mutation located, and what did the mutation do?
- A. Added restriction site at 3.0/2.5 junction
 - B. Added restriction site at 2.5/0.8 junction
 - C. Eliminated restriction site at 3.0/2.5 junction
 - D. Eliminated restriction site at 2.5/0.8 junction

Continue to the next page.

- 55-56 DNA samples were recovered from a crime scene, and DNA fingerprints were made. The gel of these samples appears below.
55. Which suspect is probably guilty of the crime? Use as your answer, the number for the suspect (1-7)
56. Which individual had the largest size fragment produced?

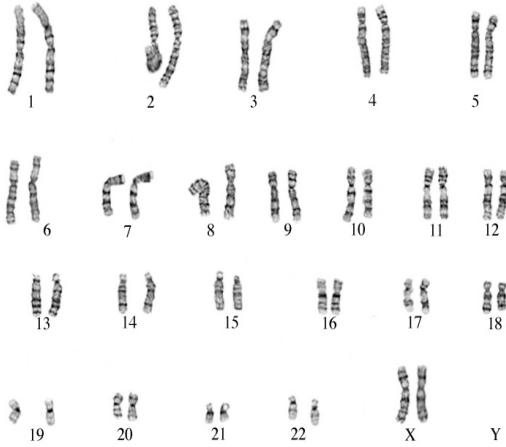


57. A 20 year old woman has a disorder that the paternal grandfather also has. The 20 year old woman's father, his older sister, and the mother of the 20 year old are all normal. The 20 year woman has a 25 year old sister who also has the disease, but her 14 and 10 year old brothers do not have the disease. Draw a pedigree that summarizes this information. Include in the pedigree only those individuals mentioned above.

Continue to the next page.

58-60 Refer to the following figures. Use the numbers 9904, 99011, 99010, 99001, 01044 if asked about a specific figure.

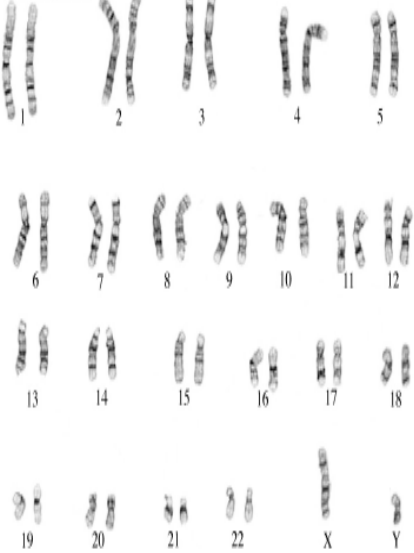
ZWK9904 KEY



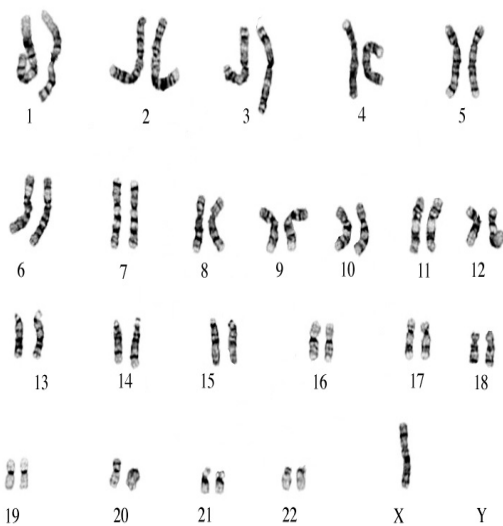
ZWK99011 KEY



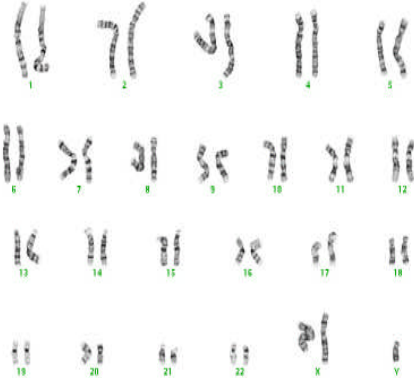
ZWK99010 KEY



ZWK99001 KEY



ZWK01044k



58. Which number represents a normal male?
59. Which number represents a person with Down's syndrome?
60. What is the sex of individual 01044