

Multiple choice. Circle the single best answer. *Do not write the letter at the side.* (4 points each)

1. A man with achondroplasia (dwarfism, rare autosomal dominant) marries a woman of normal height. Both have normal color vision but the wife's father was red-green colorblind (rare X-linked recessive). What is the probability that their first child will be color blind and of normal height?

- a) 1/16 b) 1/8 c) 1/4 d) 1/2 e) 1/3

2. *Pogonomyrmex occidentalis* has a diploid number of 64. At the end of the first meiotic division each cell consists of:

- a) two diploid nuclei
b) two replicated diploid nuclei
c) two haploid nuclei
d) two replicated haploid nuclei
e) four haploid nuclei

3. A characteristic of homologous chromosomes is that:

- a) they carry alleles for the same genes in the same relative position
b) they regularly exchange parts by crossing over at meiosis
c) they physically pair at meiosis
d) all of the above
e) none of the above

4. The pedigree below concerns the autosomal recessive disease phenylketonuria (PKU). The couple marked A and B are considering having a baby but are concerned about the baby having PKU. What is the probability of the first child having PKU?

- a) 1/4
b) 1/8
c) 1/12
d) 1/16
e) none of the above

5. Which process is most responsible for the among gamete genetic diversity that results from meiosis?

- a) mutation
b) independent assortment
c) recombination
d) all of the above
e) none of the above

6. Incomplete dominance is conclusively demonstrated when:
- heterozygotes have a different phenotype from homozygotes
 - crossing heterozygotes generates three phenotypes
 - crossing heterozygotes always produces a 1:2:1 phenotypic ratio
 - all of the above
 - none of the above
7. A solenoid consists of:
- supercoiled loops attached to a scaffold
 - a DNA molecule wrapped around a histone protein
 - a DNA molecule wrapped around a histone octomer
 - six nucleosomes stabilized by histones
 - none of the above
7. The ABO blood group segregates three alleles with complex dominance. Which of the following cannot occur (consider only the ABO locus–no interactions)?
- an B child from the marriage of an AB to an A
 - an AB child from the marriage of an A to an O
 - an O child from the marriage of two A individuals
 - an O child from the marriage of an A to a B
 - all of the above are possible
8. The table below shows the cumulative data from multiple pedigrees for five SNP loci on human chromosome 11, using in a partial linkage analysis of high blood pressure. For which marker interval(s) is there evidence supporting the hypothesis that one or more genes affecting blood pressure occur in that interval? (Circle the interval(s) with support)

Interval	distance (Cm)	LOD score
m ₁ - m ₂	0.7	3.8
m ₂ - m ₃	2.1	2.7
m ₃ - m ₄	5.0	2.7
m ₄ - m ₅	6.8	2.1
m ₅ - m ₆	3.6	1.5

9. Which of the following statements is not true?
- If a phenotype is due to a recessive allele, affected offspring may not have affected parents.
 - If a phenotype is due to a recessive allele, affected parents never have affected offspring.
 - If you make a cross between homozygous parents, and all the offspring have the phenotype of one parent, then that trait is dominant.
 - If a single copy of an allele is insufficient to produce the phenotype, then the trait is recessive.
 - The “wild type” allele may produce a dominant or a recessive phenotype.

10. In a testcross analysis to determine the linkage relationship of the recessive genes blue kernels (bl), waxy (wx), and small ears (se), you obtain the following:

parentals:	bl wx +	and	+ + se
double x-overs:	+ wx +	and	bl + se

What are the phenotypes of the parents of the heterozygous F₁ female in the testcross?

- a) blue, waxy, small and wild type
- b) blue, waxy and small
- c) blue, small and waxy
- d) blue and waxy, small
- e) you can't tell from the information given

11. A corn plant of genotype *Aa BB Cc Dd Ee ff Gg* is selfed. How many different completely homozygous genotypes could be produced?

- a) 2 b) 4 c) 8 d) 16 e) 32

12. When analyzing pedigree data, which of the following is not a valid approach?

- a) look for repeated transmission patterns in different parts of the pedigree
- b) compare offspring and parental phenotypes
- c) determine the proportion of progeny expressing the phenotype
- d) compare the likelihood of inheritance in sons versus daughters
- e) all are valid

13. Below are the results of a maximum likelihood analysis of linkage between a microsatellite marker and a inherited disease. Which, if any, of the four hypotheses is supported?

Hypothesis	RF=	0.5	0.3	0.15	0.05
Likelihood ratio		1.00	7.78	22.61	81.97
LOD score		0.0	0.89	1.35	1.91

- a) RF = 0.5 b) RF = 0.3 c) RF = 0.15 d) RF = 0.05 e) none is supported

14. In the vole, *Akodon cinereus*, coat color may be black, gray or white. Color is due to three alleles: c^b ; c^g ; c^w . Regardless of what crosses you make between coat color phenotypes, you never obtain male progeny with white coats. What must be true?

- a) white is recessive in males
- b) white is a lethal recessive on an autosome
- c) white is a lethal recessive on the X-chromosome
- d) expression of white is limited to females.
- e) the described results are impossible.

15. Which of the following indicates a sex-linked phenotype in a pedigree for any organism?

- a) parents have only one type of offspring
- b) male offspring are more likely to display the phenotype
- c) male parents are more likely than female parents to pass the trait to offspring
- d) one sex of offspring is more likely to express the trait
- e) one sex of offspring is a greater risk of inheriting the trait

16. In a cross between two individuals heterozygous for three autosomal, independently assorting loci (i.e., A/a ; B/b ; E/e), what is the probability of getting an offspring whose phenotype differs from both parents?

- a) $(1/4)^3$
- b) $(1/2)^3$
- c) $(3/4)^3$
- d) $[(3/4)^3 + (1/4)^3]$
- e) $1 - [(3/4)^3 + (1/4)^3]$

17. The tomato genes pale fruit (pf) and glabrous leaves (gl) are 32 cM apart on Chromosome 2. If a female heterozygote of genotype $pf\ gl / ++$ was testcrossed, what percent of the testcross offspring will have the phenotype of pale fruit and wild type leaves?

- a) 68%
- b) 34%
- c) 32%
- d) 16%
- e) you can't tell

Word Problems. For each of the following questions write out the answer and give an explanation of how you arrived at the solution. (10 pts each)

18. You make the following reciprocal crosses between two lines of tartigrades (water bears). One line is homozygous for the traits spiral swimming and black eyes; the other is homozygous for linear swimming and golden eyes.

	Cross A	x	Cross B
P ₀	spiral black		linear golden
		x	linear golden
			x
			spiral black
F ₁	spiral black	,	spiral black
			,
			linear black

If you cross an F₁ female from cross A with the male parent from cross B what phenotypes will you **not** expect to see in their progeny?

19. You are trying to determine the inheritance of coat color in dwarf hamsters. Coat color may be black, brown, gray or white. You have information from a number of families where only parental and offspring phenotypes are known, *not genotypes*. If you were to cross the female parent from family #6 with the male parent from family #3, what phenotypic distribution would you expect in the offspring? Explain your answer.

Cross	Parents			Offspring
1	black	x	brown	all brown
2	black	x	gray	1/2 black 1/2 gray
3	brown	x	brown	3/4 brown 1/4 black
4	black	x	white	all gray
5	brown	x	white	all brown
6	gray	x	white	1/2 gray 1/2 white
7	gray	x	gray	1/2 gray 1/4 black 1/4 white
8	gray	x	brown	1/2 black 1/2 brown

20. A female *Drosophila* that is heterozygous for the recessive, sex-linked traits of hairy wing (*h*), yellow body (*y*) and white eyes (*w*) is mated to a male that is homozygous recessive for all three traits. The phenotypic distribution of 1000 male testcross progeny is shown below:

wild type	+ + +	74
hairy yellow white	h y w	70
hairy	h + +	44
yellow white	+ y w	50
hairy yellow	h y +	2
white	+ + w	4
hairy white	h + w	368
yellow	+ y +	388

Show how you would determine the linkage relationships among the three genes. It is not necessary to have a final, numeric answer in map units, but be sure to put all numbers in the appropriate places (e.g., show how you would calculate RF value). Bonus: why do we only count male progeny?