Introduction to Genetics
FALL 2024
EXAM III

Questions 1-4 refer to the following cross.

A plant of genotype *AA bb* is crossed to a plant of genotype *aa BB*. The F_1 progeny is then testcrossed with a *aa bb* plant.

1. If the genes are unlinked, the percentage of plants with genotype *aa bb* in the F_2 progeny will be

A) 12.5% B) 25 % C) 37.5% D) 50% E) 75%

2. If the genes are 25 map units apart, the *total* percentage of recombinants in the F_2 progeny will be

A) 12.5% B) 25 % C) 37.5% D) 50% E) 75%

3. If the genes are 25 map units apart, the percentage of plants in the F_2 progeny with genotype *aa bb* progeny will be

A) 12.5% B) 25 % C) 37.5% D) 50% E) 75%

4. If the genes are 25 map units apart, the percentage of plants in the F_2 progeny with genotype *Aa Bb* progeny will be

A) 12.5% B) 25 % C) 37.5% D) 50% E) 75%

Questions 5-11 refer to the following experiment.
Smurfs are imaginary creatures who are normally blue (*B*), fuzzy (*F*), and industrious (*I*). Data from a testcross with a normal looking smurf that is known to be a trihybrid of these three linked genes are shown below.

Phenotype	Genotype	Number
Normal	*Bb, Ff, Ii*	30
White	*bb, Ff, Ii*	60
Bald	*Bb, ff, Ii*	10
Lazy	*Bb, Ff,* ii	400
White, bald	*bb, ff, Ii*	400
White, lazy	*bb, Ff, ii*	10
Bald, lazy	*Bb, ff, ii*	70
White, bald, lazy	*bb, ff, ii*	20
	Total:	1000

5. What were the parental genotypes of this testcross?

A) *BFi / bfI* B) *BFI / bfi* C) *BfI / bFi* D) *Bfi / bfi* E) *BFI / BFI*

6. What is the distance in map units with respect to the B and F genes?

A) 2 mu B) 7 mu C) 15 mu D) 18 mu E) 20 mu

7. What is the distance in map units with respect to the F and I genes

A) 2 mu B) 7 mu C) 15 mu D) 18 mu E) 20 mu

8. What is the distance in map units with respect to the I and B genes

A) 2 mu B) 7 mu C) 15 mu D) 18 mu E) 20 mu

9. What is order of the three genes?

A) B-F-I B) F-I-B C) F-B-I D) A or B could be correct E) B or C could be correct

10. What was the observed frequency of double recombinants in this cross?

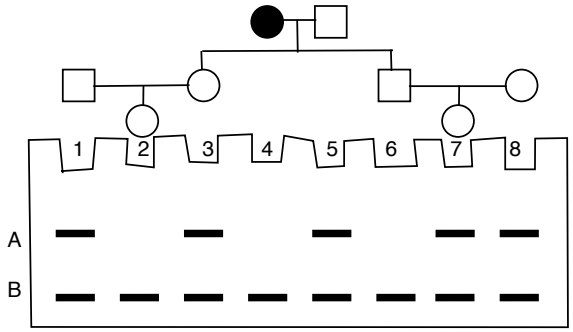
A) 0.0100 B) 0.0105 C) 0.0200 D) 0..0270 E) 0.0070

11. What was the expected frequency of double recombinants in this cross, given the map distances of these genes?

A) 0.0100 B) 0.0105 C) 0.0200 D) 0.0270 E) 0.0070

Questions **12-15** refer to the pedigree shown on the right.

A female has a rare recessive disease that is 75% linked to the AB locus.



12. Female #3 inherited

A) Both B alleles from her mom
B) Both B alleles from her dad
C) The A allele from her dad and the B allele from her mom
D) The B allele from her dad and the A allele from her mom
E) The B allele from her dad and the B allele from her mom

13. Male #6 inherited

A) Both B alleles from his mom
B) Both B alleles from his dad
C) The A allele from his dad and the B allele from his mom
D) The B allele from his dad and the A allele from his mom
E) The B allele from his dad and the B allele from his mom

14. The probability that female #2 is a carrier of the disease is

A) 12.5% B) 25% C) 50% D) 75% E) 100%

15. The probability that female #7 is a carrier of the disease is

A) 12.5% B) 25% C) 50% D) 75% E) 100%

Questions 16-21 refer to the following experiment.
The yeast *Saccharomyces cerevisiae* has unordered tetrads. In a cross made to study the linkage relationship between three genes, the following tetrads were obtained. The cross was between a strain of genotype *A b d* and one of genotype *a B D.*

Tetrad	Genotypes of spores in tetrads				# of tetrads
1	*aBD*	*aBD*	*Abd*	*Abd*	150
2	*aBD*	*aBd*	*AbD*	*Abd*	50
3	*abD*	*abD*	*ABd*	*ABd*	140
4	*abD*	*abd*	*ABD*	*ABd*	60
				Total	400

PD=parental ditype, NPD=nonparental ditype, TT=tetratype

16. The correct classification of tetrads 1, 2, 3, and 4 with respect to A and B is

A) NPD, PD, NPD, PD
B) TT, TT, PD, PD
C) PD, NPD, TT, TT
D) PD, PD, TT, TT
E) PD, PD, NPD, NPD

17. The distance in map units between the A and B genes is

A) 6.25 mu B) 13.75 mu C) 25.0 mu D) 27.50 mu E) A and B are unlinked

18. The correct classification of tetrads 1, 2, 3, and 4 with respect to B and D is

A) NPD, PD, NPD, PD
B) PD, TT, NPD, TT
C) PD, NPD, TT, TT
D) PD, PD, TT, TT
E) PD, NPD, NPD, PD

19. The distance in map units between the B and D genes is

A) 6.25 mu B) 13.75 mu C) 25.0 mu D) 27.50 mu E) B and D are unlinked

20. The correct classification of tetrads 1, 2, 3, and 4 with respect to A and D is

A) NPD, PD, NPD, PD
B) PD, NPD, PD, NPD
C) PD, TT, PD, TT
D) PD, PD, TT, TT
E) PD, NPD, NPD, PD

21. The distance in map units between the A and D genes is

A) 6.25 mu B) 13.75 mu C) 25.0 mu D) 27.50 mu E) A and D are unlinked

22. A male is known to be heterozygous for an paracentric inversion on chromsome 12. During meiosis, if a cross-over occurs *outside* of the region containing the inversion, the products of that meiosis would produce gametes that have:

A) 2 viable gametes, and 2 inviable gametes containing a Robertsonian translocation.
B) 2 viable gametes, and 2 inviable gametes containing a reciprocal translocations.
C) 4 inviable gametes, with 2 containing dicentric and/or acentric chromosome 12.
D) 4 inviable gametes, two monocentric chromosome 12 that contain deletions or duplications.
E) 4 viable gametes, two of which have an inversion on chromosome 12.

23. Meiosis in a cell with Trisomy 21 (Down's syndrome) would result in

A) four aneuploid gametes.
B) four euploid gametes
C) two normal gametes and two gametes that contain two copies of chromosome 21.
D) two normal gametes and two gametes with a paracentric inversion
E) two normal gametes and two gametes with a nonreciprocal translocation

24. A diploid strain of kiwi plant has *only 1 chromosome pair* (ie. 2n=2). The tetraploid strain of the same species is also viable and fertile. When the diploid strain is crossed with the tetraploid strain, the progeny are viable, grow well, and produce tasty fruit. Which of the following is true of the progeny?

A) Half the progeny are diploid, half are tetraploid.
B) Half the progeny are aneuploid, but likely fertile.
C) All the progeny are triploid, but are essentially sterile.
D) All the progeny are triploid, but their fertility would likely be reduced by ~ 50%.
E) All the progeny are triploid, and likely fertile.

25. Three major types of genetic transfer are found in bacteria: _____, in which a DNA molecule is taken up from the external environment and incorporated into the genome; _____, in which donor DNA is transferred from one bacterial cell to another by direct contact; and _____, in which DNA is transferred from one bacterial cell to another by a bacterial virus.

A) transduction, conjugation, transformation
B) conjugation, transformation, transduction
C) conjugation, transduction, transformation
D) transformation, conjugation, transduction
E) transformation, transduction, conjugation

26. In a mating between Hfr donor (in which the conjugative F plasmid has integrated into the chromosome) and F^- recipient, the recipient

A) remains an F- B) becomes an F+ C) becomes an Hfr D) becomes an F′ E) remains lysogenic

Questions 27 - 29 refer to the following experiment:
In a generalized transduction experiment donor *E. coli* cells have the genotype a^+ *b*- c^+, and recipient cells have the genotype *a*- b^+ *c*-. Pl-mediated transductants for a^+ were selected, and their total genotypes were determined, with the following results:

Genotype	Number of progeny
a^+ *b*- c^+	95
a^+ *b*- *c*-	205
a^+ b^+ c^+	5
a^+ b^+ *c*-	195
	500

27. What is the cotransduction percentage for *a* and *b?*

A) 20% B) 40% C) 58% D) 60% E) 80%

28. What is the cotransduction percentage for *a* and *c?*

A) 20% B) 40% C) 58% D) 60% E) 80%

29. Which gene is closest to gene 'a'?

A) they are equidistant
B) b
C) c
D) one must repeat the experiment selecting for 'b' before this can be determined
E) one must repeat the experiment selecting for 'c' before this can be determined

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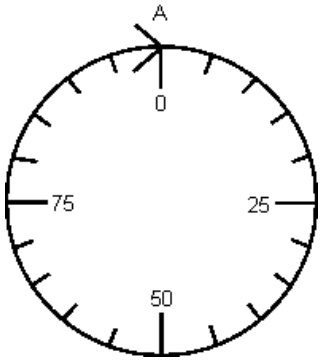
Questions 30 - 33 refer to the following experiment:

An interrupted-mating experiment is performed with *E. coli*. Three different x^+y^+ Hfr strains are mixed one at a time with an x^- y^- F^- strain. The progeny are screened on appropriate selective media to detect recombinants. The number of minutes after mixing the parents that the Hfr marker first appeared in the recombinants from each cross are given below. Assume a 100-minute map.

Cross	Hfr markers x^+	y^+
Hfr A strain x F^-strain	15min	30min
Hfr B strain x F^-strain	40min	55min
Hfr C strain x F^-strain	90min	05min



30. If the F plasmid in Hfr A integrated at 0 minutes on the bacterial chromosome as shown above and transfers DNA in a counterclockwise direction, what is the position of gene *x* and *y* on the genetic map, respectively?

A) at 15min & 30 min
B) at 25min & 50 min
C) at 50min & 75 min
D) at 80min & 60 min
E) at 85min & 70 min

31. What is the distance in minutes between where Hfr A and Hfr B integrated on the bacterial chromosome?

A) 10 min B) 15 min C) 25 min D) 30 min E) 40 min

32. Where did the F plasmid integrate in Hfr C?

A) at 5 min B) at 10 min C) at 45 min D) at 75 min E) at 90 min

33. Which Hfr(s) transfer DNA in the same direction as Hfr A? (ie counterclockwise)?

A) Both Hfr B and C B) Hfr B C) Hfr C D) neither Hfr B or C E) it can't be determined

Potentially Useful formulas

% Recombinants = (# recombinants) / (# total progeny) x 100%

map distance = (# recombinants) / (# total progeny) x 100

For n trials, the probability that A, having probability p, is realized s times and B, having probability q, is realized t times is equal to (n!)/(s!t!) x ($p^s q^t$)

map distance = ½ x (# tetratype tetrads) / (# total tetrads) x 100
map distance = ½ x (# ascii with 2nd division segregation) / (# total ascii) x 100