Introduction to Genetics
FALL 2010
EXAM III

1. 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

Questions 2 - 4 refer to the following experiment:
In a generalized transduction experiment donor *E. coli* cells have the genotype $a^+ c^+ b^-$, and recipient cells have the genotype $a^- c^- b^+$. Transductants for a^+ were selected, and their total genotypes were determined, with the following results:

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

2. What is the cotransduction frequency for *a* and *b?*

A) 19.5% B) 20% C) 40% D) 60% E) it cannot be determined from this experiment

3. What is the cotransduction frequency for *a* and *c?*

A) 19.5% B) 20% C) 40% D) 58% E) it cannot be determined from this experiment

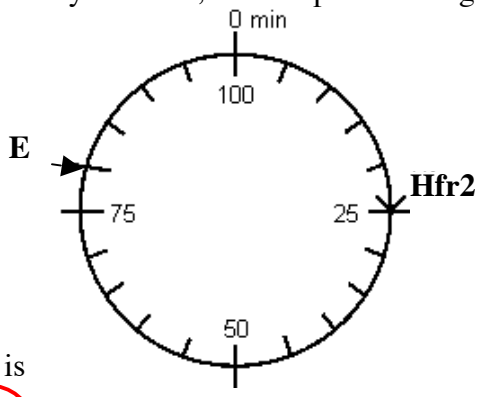
4. Which gene is closer to gene *a?*

A) they are equally close B) gene b C) gene c D) it cannot be determined

Questions 7 - 10 refer to the following experiment:

An *E. coli* F^- strain has the following genotype: $A^- B^- C^- D^- E^- G^-$. Three different Hfr strains, all carrying $A^+ B^+ C^+ D^+ E^+ G^+$ markers are mated with the F- strain in separate matings. The interrupted-mating results are given below. The numbers indicate time (in minutes) when different donor markers appeared in F^- cells after conjugation began. Assume that the *E. coli* map consists of 100 minutes. The position and polarity of Hfr 2, and the position of gene *E* are given in the accompanying map.

Markers	Hfr 1	Hfr 2	Hfr 3
A	10	20	–
B	40	–	5
C	25	5	–
D	–	60	–
E	–	45	–
G	55	–	20



5. The gene order, starting from *E* and going clockwise is

A) *EDGBCA* B) *EBCAGD* C) *EACDBG* D) *EACBGD* E) *EDCABG*

6. What is the location of the origin for Hfr 1and Hfr 3?

A) 85min; 30min B) 35min; 50min C) 50min; 30min D) 50min; 20min E) 95min; 30min

7. What is the direction of transfer for Hfr 1and Hfr 3?

A) Both transfer in a clockwise direction
B) Both transfer in a counterclockwise direction
C) Hfr 1 transfers clockwise, Hfr 3 transfers counterclockwise
D) Hfr 1 transfers counterclockwise, Hfr 3 transfers clockwise
E) Hfr 1 transfers counterclockwise, but Hfr 3 cannot be determined

8. What is the location of the *B* and *G* markers?

A) 85min; 30min B) 35min; 50min C) 50min; 30min D) 50min; 20min E) 95min; 30min

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Questions 9 - 11 refer to the following experiment:
Phenyketonuria is an inborn error of metabolism caused by autosomal recessive gene. The frequency of this allele in the population is 0.03.

9. Assuming Hardy-Weinberg equilibrium, what is the expected incidence of phenyketonuria among the offspring of all matings in which both parents are known to be carriers?

A) 0.0009 B) 0.015 C) 0.03 D) 0.0582 E) 0.25

10. Assuming Hardy-Weinberg equilibrium, what is the expected incidence of phenyketonuria among the offspring of all matings in which one parent is known to be carrier?

A) 0.0009 B) 0.0075 C) 0.015 D) 0.03 E) 0.25

11. Assuming Hardy-Weinberg equilibrium, what is the expected incidence of phenyketonuria among the offspring of all matings in which it is not known if either parent is a carrier?

A) 0.0009 B) 0.0075 C) 0.015 D) 0.03 E) 0.25

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12. What factor could cause the allelic frequencies of a gene to shift randomly within a population?

A) Genetic drift B) High mutation rate C) Assortative mating D) Migration E) Natural selection

13. In a population with two alleles, *B* and *b*, the frequency of *b* is 0.56. What would be the frequency of the heterozygotes, assuming Hardy-Weinberg equilibrium?

A) 0.44 B) 0.38 C) 0.71 D) 0.31 E) 0.49

14 An allele *A* undergoes mutation to the allele *a* at the rate of 10^{-3} per generation. In a very large population, where the frequency of *A* is 0.8, what is the expected frequency of *A* in the following generation?

A) 0.6498 B) 0.7239 C) 0.7992 D) 0.9048 E) 0.9990

15. An allele *A* undergoes mutation to the allele *a* at the rate of 10^{-3} per generation. In a very large population, where the frequency of *A* is 0.8, what is the expected frequency of *A* after 100 generations?

A) 0.6498 B) 0.7239 C) 0.7992 D) 0.9048 E) 0.9990

16. A trait due to a recessive X-linked allele in a large, randomly mating population affects one male in ten. What is the frequency of affected females?

A) 1 in 10 B) 1 in 20 C) 1 in 50 D) 1 in 100 E) 1 in 200

17. Inbreeding results in

A) increased frequency of heterozygotes.
B) increased frequency of homozygotes.
C) increased frequency of rare recessive alleles.
D) increased frequency of dominant alleles.
E) increased frequency of mutations

Questions 18 - 20 refer to the following experiment:
A tropical island population is in Hardy-Weinberg equilibrium for the autosomal locus determining the presence/absence of pigment in the skin. The frequency of albinism (*aa*) on the island is 1 in 10,000.

18. What is the frequency of the *a* allele in the population?

A) 0.0001 B) 0.0100 C) 0.0198 D) 0.0199 E) 0.0250

19. Suppose that the island experiences a rapid influx of immigrants so that the population doubles overnight. If the frequency of albinism (*aa*) among the arriving immigrants is 1 in 1,000. What is the new frequency of the a allele?

A) 0.0198 B) 0. 0208 C) 0. 0316 D) 0.0388 E) 0.0407

20. If after the immigrants arrive, all the parameters for maintaining Hardy-Weinberg equilibrium are met, what will the new frequency of heterozygotes be in the population when it reaches Hardy-Weinberg equilibrium?

A) 0.0006 B) 0. 0208 C) 0. 0316 D) 0.0388 E) 0.0407

Questions 21–24 refer to the following
Hurler syndrome is an autosomal recessive disease caused by a deficiency of the enzyme alpha-L-iduronidase. Affected individuals are mentally retarded, have skeletal abnormalities and short stature. An large island population in the Pacific has incidence of about 1 in 2,500. Assume the allele is at Hardy-Weinberg equilibrium.

21. What is the frequency of the Hurler syndrome allele in this population?

A) 0.0768 B) 0.0004 C) 0.0080 D) 0.0200 E) 0.0392

22. What is the frequency of carriers for Hurler syndrome in this population?

A) 0.0768 B) 0.0004 C) 0.0080 D) 0.0200 E) 0.0392

23. Within this population, what is the increased risk of Hurler syndrome among the offspring of first-cousin matings, where the inbreeding coefficient equals 1/16? (How many times more likely than among unrelated matings?)

A) 2 times B) 4 times C) 10 times D) 16 times E) 256 times

24. A couple from the island, Jane and Biron, tell you that Jane's sister Maureen has Hurler syndrome. They are concerned that they might have a child with the same disorder. What is the probability that the couple's first child will have Hurler syndrome?

A) 0.0133 B) 0.0004 C) 0.0100 D) 0.0049 E) 0.0067

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25. Given a population with the genotypic frequencies of *AA* =0.39, *Aa* = 0.56 and *aa* = 0.05, what will the genotype frequencies be at Hardy-Weinberg equilibrium?

A) *AA* =0.39, *Aa* = 0.56 and *aa* = 0.05
B) *AA* =0.45, *Aa* = 0.44 and *aa* = 0.11
C) *AA* =0.77, *Aa* = 0.39 and *aa* = 0.05
D) *AA* =0.39, *Aa* = 0.26 and *aa* = 0.72
E) *AA* =1.00, *Aa* = 0.00 and *aa* = 0.00

Questions 26 - 28 refer to the following experiment.
For many generations, the following genotypic frequencies were observed in a large population of dinosaurs: 4 percent *AA*, 32 percent *Aa*, and 64 percent *aa*. A cold winter resulted in the death of all homozygous recessive dinosaurs (reducing their fitness to 0).

26. What is the percentage of *aa* dinosaurs born in the generation after the cold winter?

A) 2.5% B) 8.5% C) 19.8% D) 37.6% E) 44.4%

27. What was the frequency of the *a* allele after the cold winter?

A) .09 B) 0.20 C) 0.38 D) 0.44 E) 0.56

28. If the cold winter was an unusual event and the climate returned to normal thereafter, what would the new frequencies be when they returned to Hardy-Weinbeg equilibrium.

A) 56% AA; 44% Aa; 0% aa
B) 36% AA; 64% Aa; 0% aa
C) 44% AA; 53% Aa; 3% aa
D) 31% AA; 49% Aa; 20% aa
E) 10% AA; 36% Aa; 54% aa

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29. The genotypic variance of the F_1 progeny of a cross between two inbred lines equals

A) the total phenotypic variance B) the environmental variance C) 0 D) 0.5 E) 1

30. The distribution of height among 1000 newborn boys has the mean of 50 cm and the *variance* of 4 cm^2. Assuming a normal distribution, how many boys are expected to be between 50 and 54 cm tall?

A) 340 B) 475 C) 680 D) 950 E) 990

31. The difference in the mean length of corolla tube between two lines of tobacco is 6 mm and the genotypic variance is estimated as 1.12 mm^2. Assuming this trait is controlled by additive alleles, what is the minimum number of additive alleles involved in this trait?

A) 1 B) 3 C) 4 D) 8 E) 12

32. A broad sense heritability (H^2) of 0.90 means

A) 90% of the variation in a population is due to the environment.
B) 10% of the variation in a population is heritable.
C) 90% of the population will fall within one standard deviation of the mean.
D) 90% of the variation in a population is due to genotype differences.
E) 90% of the variation in the population is due to additive alleles

33. If after several rounds of artificial selection all alleles affecting the trait are fixed or lost, the narrow-sense heritability of the trait will be

A) 0 B) 0.5 C) 1 D) 2 E) undeterminable

Question 34 and 36 refer to the following:
Five polygenic loci each with two alleles affect a quantitative phenotype, wing length, in fruit flies. Assume each dominant allele has the same additive effect, 0.5 mm, on wing length.

34. How many different classes of internode length will there be?

A) 5 B) 10 C) 11 D) 32 E) 1024

35. What range in size would be expected to occur between the shortest and longest wings?

A) 2.5mm B) 5.0mm C) 5.5mm D) 10mm E) 25m

36. A genetically heterogeneous population of rice has a mean number of 30 days to maturation. Selection for decreased period of maturation is carried out for one generation. The average period to maturation among the plants selected as parents for the next generation is 25 days. F_1 plants mature on average in 27 days. Estimate the narrow sense heritability.

A) 0.100 B) 0.833 C) 0.600 D) 0.400 E) 0.900

Questions 37 - 39 refer to the following:
The mean length and variance of stem length in two inbred varieties of roses and their progeny are shown below.

Variety	Mean Length (cm)	Variance (cm^2)
I short	40.47	3.124
II long	93.75	3.876
F_1	63.90	4.743
F_2	68.72	47.708

37. What is the environmental variance?

A) 0 B) 2.257 C) 4.743 D) 42.965 E) 47.708

38. What is the genetic variance?

A) 0 B) 2.257 C) 4.743 D) 42.965 E) 47.708

39. Calculate the broad-sense heritability.

A) 0.099 B) 0.147 C) 0.853 D) 0.901 E) 0.246

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40. RNA is prepared from the cells of a cancerous tumor and labeled with red fluorescent tag. RNA is also prepared from the cells of a normal tissue and labeled with green fluorescent tag. The RNA samples are then allowed to competitively hybridize to a microarray chip. A sample of the results from several genes on the microarray are shown below:

Gene W	Gene X	Gene Y	Gene Z
Black	Red	Yellow	Green

Which of the following is true of each gene's expression in tumor as compared to normal cells?

A) W is mutated, X is downregulated, Y expression remains unchanged, Z is not expressed.
B) W is downregulated, X is upregulated, Y expression remains unchanged, Z is not expressed.
C) W is not expressed, X is upregulated, Y expression remains unchanged, Z is downregulated.
D) W expression remains unchanged, X is downregulated, Y is not expressed, Z is upregulated.
E) W expression remains unchanged, X is upregulated, Y is not expressed, Z is downregulated.