BIL 250 - Spring 2001 **Krempels**

EXAM II

Choose the BEST answer. Two points each.
IMPORTANT TIP: If you have trouble with a problem, skip it and come back to it later!

1. In a species of wild *Phlox* flower, a single gene locus codes for flower petal pigment. One allele of this gene codes for red pigment, and a different allele codes for blue pigment. A plant that is homozygous for the red allele produces red flowers. A plant that is homozygous for the blue pigment produces blue flowers, and a heterozygous plant produces purple flowers. Which of the following is true?
   a. the two alleles in question exhibit incomplete dominance
   b. the two alleles in question exhibit codominance
   c. purple flowers must be considered the "wild type" phenotype
   d. a plant with purple flowers exhibits heterozygote advantage
   e. more than one of the above is true

2. If you had two purple-flowering *Phlox* (from the previous question) and you bred them together and got 10 seeds, what is the probability that 4 of the seeds will produce a blue-flowering plant, and 6 will produce a purple-flowering? (Hint: equations are on the last page!)
   a. 0.02 b. .013 c. 0.05 c. .0.63 d. 0.5

3. In a cat with a sex chromosome karyotype of XXXXY, how many Barr Bodies would you expect to find in each somatic cell?
   a. one b. two c. three d. four e. none

4. The cat of the previous question has a condition known as
   a. Turner Syndrome c. Klinefelter Syndrome e. extra nipples
   b. Down Syndrome d. Cri-du-Chat Syndrome

5. Human stature is controlled by about seven different genes at separate loci. This trait is
   a. codominant c. polygenic e. complementary
   b. epistatic d. heterokaryotic

6. You have a stallion who expresses a dominant allele for coat color (bay) and the dominant allele for mane texture (straight). However, there are recessive alleles for each of these loci coding for black coat color and wavy mane. You don't know the genotype of your stallion, but would like to find out. To do so, you should breed him with which of the following?
   a. a true-breeding bay mare with straight mane d. an albino mare with straight mane
   b. a true-breeding black mare with wavy mane e. a frisky goat
   c. a mare heterozygous for both traits

7. The primary sex ratio (males: females) in the U.S. is 1.08. The secondary sex ratio is 1.06. Which of the following is the most plausible explanation for the reduction in number of males between conception and birth?
   a. insufficient sample size
   b. hemizygosity of males results in expression of deleterious lethal alleles on the X c'some
   c. males are more likely to express deleterious alleles on the autosomal chromosomes
   d. Any given X chromosome in a female is less likely to carry a deleterious allele than an X chromosome in a male.
   e. males prefer to stay with mom

8. Because a female has two X chromosomes and a male has only one, a female produces twice the amount of product encoded on the X chromosome as a male.
   a. true b. false c. which explains a lot, actually

9. A trait such as male pattern baldness, which exhibits opposite dominance/recessiveness in males and females is known as a(n) _____ trait.
   a. holandric c. sex-limited e. sex-linked
   b. pseudoautosomal d. sex-influenced

Use the following information to answer #10 - 13.

In unicorns, the direction of horn spiral (I'm really reaching here…) is determined, not by the genotype of the unicorn itself, but by the direction of the mitotic spindle's tilt in the ovum made by its ***mother***. A female unicorn carrying the dominant allele (H) will manufacture ova with the mitotic spindle tilting to the left, and causing babies developed from her fertilized ova to have a left-spiraling horn. A unicorn carrying only the recessive allele (h) will manufacture ova with the mitotic spindle tilting to the right, and causing all her babies to have right-spiraling horns.

10. The direction of unicorn horn spiraling is determined by
    a. simple Mendelian genetic interactions
    b. mitochondrial inheritance
    c. maternal effect
    d. maternal inheritance
    e. epigenesis

11. A right-spiral female unicorn with the genotype Hh mates with a left-spiral male with genotype Hh. What is the likelihood that her first baby's horn will spiral to the right?
    a. 0% b. 25% c. 50% d. 75% e. 100%

12. After a few seasons, the unicorn pair in the previous question have produced babies of both sexes and with all possible genotypes, HH, Hh and hh. In which direction will the horns of babies produced by this pair spiral?
    a. right b. left c. both right & left d. not enough information given

13. Another unicorn pair, this time an hh male and an Hh female, mate to produce a female offspring with a left-spiraling horn. When this little filly has a baby of her own, however, its horn spirals to the left. What is her genotype?
    a. HH b. Hh c. hh d. need more information

14. Which of the following is true of both mitochondria and chloroplasts?
    a. Their DNA is circular
    b. Their genetic code is always exactly the same as the "universal" code proposed by Crick
    c. They can function completely without using any gene products of nucDNA
    d. The genes they encode have no effect on the phenotype of the organism.
    e. All of the above are true of mitochondria and chloroplasts.

15. A number of mammals have been successfully cloned, their "creators" claiming that they are completely genetically identical to the animal that donated the nucleus from which the clone was grown. Why is this not absolutely true?
    a. A cloned organism's DNA replication enzymes are manufactured in the cytoplasm.
    b. A cloned monkey's chloroplasts produce enough sugar to make it sweeter than the donor.
    c. Mitochondria are (maternally) inherited from the animal who donated the ovum, and this animal is not the same one who donated the cloned nucleus.
    d. Mutation of nucDNA usually occurs during to the cloning process
    e. Unlike the animal who donated their nucleus, cloned organisms are immortal

16. The process by which genetically distinct mitochondria or chloroplasts in a single cell gradually duplicate and move into separate daughter cells over several mitotic divisions (so that eventually each daughter cell has only one genetic strain of mitochondria or chloroplast) is known as
    a. Independent Assortment
    b. Principle of Segregation
    c. Entropy
    d. Cytoplasmic Segregation and Recombination
    e. The Plastid Polka

17. A woman who has the genetic disorder PKU cannot safely have children, as the toxic breakdown products of phenylalanine in her system can damage the central nervous system of her unborn child. There is absolutely no way to prevent this nervous system damage.
    a. true b. false c. maybe, but I'm not telling

Use the following information to answer #18 - 23

A species of Amazonian Poison Dart Frog has three color morphs in its wild populations. Some frogs are solid black, some are solid red, and others are mottled with patches of both black and red. In doing a population study on these frogs, you capture 10,000 of them, sex them, record their color pattern and release them. Of the 10,000 frogs you captured, 5000 were male and 5000 were female (how convenient!). Of the male frogs, 3500 were solid black, and 1500 were solid red. Of the females, 2500 were solid black, and 1500 were solid red, and 1000 were mottled red/black.

18. When you first began studying these frogs, you hypothesized that skin color was due to an autosomal gene locus segregating three alleles, and that the allele coding for black skin (R) was dominant to one coding for red skin (r), which was dominant to an allele coding for mottled red/black skin (r'). If your initial hypothesis is correct, then what ratio of phenotypes would you expect in the offspring of a true-breeding black male with a mottled red/black female?
    a. 50% black offspring, 50% red offspring; no difference in color ratio between the sexes
    b. 1:1 ratio of black to red in males; 100% black females
    c. 100% black females; 100% red males
    d. 100% black offspring, male and female
    e. 50% black offspring; 50% red/black mottled offspring; no difference in color between sexes

19. When you actually bred the two individuals above, you managed to raise 100 little froglets to maturity. The offspring cohort had the following phenotypes:

    22 black females **30 black males**
    28 red/black mottled females **20 red males**

    From these data, you suddenly realized that you must be dealing with an X-linked trait with only two loci, black (R) or red (r)! If this *new* hypothesis is correct, then the genotype of the original male parent was _____ and the original female parent was _____.
    a. male: X^RY^r Female: $X^R X^r$
    b. male: X^RY^R Female: $X^R X^R$
    c. male: X^RY Female: $X^R X^r$
    d. male: X^RY Female: $X^r X^r$
    e. male: X^rY Female: $X^R X^r$

Use a Chi-square test to determine whether your observed phenotypic ratios are significantly different from those predicted by Mendel's Law, using your second idea (i.e., this trait is X-linked) to devise your null hypothesis. (Hint #1: you have **four** phenotypic classes from which to calculate your degrees of freedom. Hint #2: Use the **actual numbers of individuals** in each phenotypic class, not their percentage/proportion of the total. Hint #3: Chi-square equations and table of critical values are on the last page of the exam.).

20. What is your overall Chi-square value?
    a. 0.36 b. 0.5 c. 1.72 d. 2.72 e. 0.05

21. What is the Probability that the deviation of your observed data from the expected is due to random chance?
    a. between 0.99 and 0.97
    b. between 0.9 and 0.5
    c. between 0.5 and 0.1
    d. between 0.1 and 0.05
    e. between 0.05 and 0.01

22. If you correctly answered #21, you must now _____ your null hypothesis.
    a. accept b. reject c. make up d. pretend you understand

23. If your new idea is correct, and skin color in these frogs is X-linked, then the red/black color in the females is probably due to
    a. heterozygote advantage
    b. codominance
    c. incomplete dominance
    d. hybrid vigor
    e. mosaic expression

24. A population of beetles you're studying in the Pacific Northwest has elytra (wing covers) that come in several different colors, including irridescent green, irridescent blue and black. If you count the numbers of each color beetle in your population, you are collecting
    a. discrete numerical data
    b. parametric data
    c. attribute data
    d. continuous numerical data
    e. more than one of the above

Use the following information to answer questions #25 - 31.

You are breeding butterflies, and are interested in detemining the relationship of three different traits your particular species expresses. Wild type butterflies have a black body (wh^+), blue eyes (r^+), and silver wings(gld^+),. But each of these genes also segregates a mutant allele. Butterflies who are mutant at all three loci have a white body (*wh*), red eyes (*r*) and gold wings (*gld*). You have no idea at the outset whether the three loci are on the same chromosome, or different chromosomes.

You do, however, have a true-breeding colony of wild type butterflies, and another true-breeding colony of white-bodied, red-eyed, gold-winged butterflies. You take a male wild type butterfly, breed it with a female mutant at all three loci, and get a clutch of 100 eggs, all of which hatch out and metamorphose into butterflies that express the wild type for all three traits.

Note that when I write the genotypes below, I am not necessarily indicating that the gene loci are either linked on a single chromsome OR that they exist in that order on a single chromosome.

25. The genotype of your 100 new butterflies is _____. To most effectively study the linkage arrangement of the three loci above, you should breed one of your 100 new individuals with a butterfly whose genotype is _____.
    a. $wh^+wh^+\ r^+r^+\ gld^+gld^+$ and $wh^+wh^+\ r^+r^+\ gld^+gld^+$——
    b. $whwh\ rr\ gldgld$ and $wh^+wh\ r^+r\ gld^+gld$
    c. $wh^+wh\ r^+r\ gld^+gld$ and $wh^+wh\ r^+r\ gld^+gld$
    d. $wh^+wh^+\ r^+r^+\ gld^+gld^+$ and $whwh\ rr\ gldgld$
    e. $wh^+wh\ r^+r\ gld^+gld$ and $whwh\ rr\ gldgld$

26. If the three loci are **completely unlinked** (yes, you have to know what that means, and I'm not going to tell you) then which of the following is closest to what you would expect to find in a cohort of 10,000 offspring from a trihybrid cross?
    a. 10,000 completely wild type
    b. 5000 wild type, 5000 white/red/gold
    c. 1250 wild type, 1250 white/red/gold, 1250 white, 1250 red/gold, 1250 red, 1250 white/gold, 12.5% gold, 12.5% red/white,
    d. 3333 wild type, 3333 fully mutant, 3333 white
    e. 5625 wild type : 1875 white : 1875 red/gold : 625 white/red/gold

You decided to breed a butterfly with the genotype $wh^+wh\ r^+r\ gld^+$gld to a butterfly with genotype *whwh rr gldgld*, and successfully raised 10,000 little caterpillars into lovely little butterflies that batted around their jars for a day or so, sipping nectar, and then died. But before they went to that big Butterfly Garden in the sky, you counted up the following numbers in each of the following phenotypic classes:

PHENOTYPE	# OF INDIVIDUALS
wild type	3900
red	200
white/red	40
white/gold	300
red/gold	800
gold	60
white	900
white/red/gold	3800
Total	**10,000**

Using your Super Cerebrum Skills, you quickly did a statistical test in your head and determined that the likelihood of these phenotypic classes occurring in the ratios shown above is significantly different from that predicted by chance alone. You surmise (correctly) that the three loci are located on the same chromosome. But how close together are they? And in what order! Ah, that's what we're here to determine, isn't it?

(continued on the following page)

27. Which gene is the inside marker?
    a. body color (*wh*)
    b. eye color (*r*)
    c. wing color (*gld*)
    d. need more information to determine
    e. all of the loci are in the middle

28. What is the measured map distance (in Centimorgans) between the *wh* and *gld* loci?
    a. 6.0 b. 18.0 c. 22.0 d. 24.0 e. need inside marker to determine

29. What is the actual map distance (in Centimorgans) between the *wh* and *r* loci?
    a. 6.0 b. 18.0 c. 22.0 d. 24.0 e. need inside marker to determine

30. Judging from the number of crossovers you actually observed between your two outside loci, how many of the 10,000 flies would you EXPECT to have inherited a double crossover? (Hint: use the map distances you just calculated as probabilities of any given crossover!)
    a. 100 b. 108 c. 120 d. 180 e. 220

31. From the expected number of double crossovers you calculated in #28, calculate the Coefficient of Coincidence. Judging from the c.c. you calculated, a crossover between the *wh* and *gld* loci _____the chance of another crossover occuring between the *r* and *gld* loci.
    a. increases b. decreases c. does not affect

32. The mutation responsible for the genetic disorder Sickle Cell Anemia affects the phenotypic expression of many traits besides the morphology and physiology of the red blood cells. This phenomenon is know as
    a. polygenic trait
    b. epistasis
    c. epigenesis
    d. pleiotropy
    e. heterozygote advantage

33. The scientific team who observed the cytogenetic markers of corn, and first made the connection between crossing over and exchange of genetic material between homologous chromosomes was
    a. Sturtevant and Morgan
    b. Watson and Crick
    c. Creighton and McClintock
    d. Washburn and Eicher
    e. The Osmond Brothers

34. In which of the following organisms might a somatic mutation be passed to future generations?
    a. Rhesus monkey
    b. *Drosophila*
    c. *Sequoia* tree
    d. Pepper moth
    e. more than one of the above

35. An identifying structure visible upon microscopic study of a chromosome is called a
    a. Giemsa band
    b. gene marker
    c. tetrad marker
    d. knockout marker
    e. cytological marker

36. Which of the following is TRUE of mtDNA, but NOT TRUE of nucDNA in mammals
    a. it can code for enzymes involved in the electron transport chain
    b. both strands (sense *and* antisense) of the double helix are transcribed
    c. it is transcribed by an RNA polymerase encoded by genes in the nucleus
    d. it is inherited, *either completely or in part*, from the maternal parent
    e. All of the above are true of BOTH mtDNA and nucDNA

37. A deleterious mutation in an essential gene will most often
    a. encode improved version of the protein coded by the gene
    b. force an extragenic suppressor mutation
    c. be inherited as a dominant allele
    d. confer hybrid vigor
    e. be lethal

38. All members of a (hypothetical) population of snakes have a gene that encodes a certain orange pigment. However, due to the effects of nearby genes (epistatic genes, modifiers, etc.) which interact with this gene, some snakes in the population do not express the orange pigment at all (they're white). The population of snakes shows variable
    a. expressivity
    b. penetrance
    c. transcription
    d. gene markers
    e. interaction

39. In another population of this snake having the same gene coding for pigment production, the amount of pigment made varies among individuals of the population due to interacting genes and environmental effects. There is a range of color morphs in this population from dark orange to various shades of pale orange to almost white. This population shows variable
a. longevity
b. chromosomes
c. penetrance
d. expressivity
e. emotion

40. In an individual organism, short-term change (via gene expression) in response to environmental factors is known as
a. epigenesis
b. adaptation
c. microevolution
d. macroevolution
e. more than one of the above

41. A particular triplet code in an enzyme gene encodes tyrosine. However, a tragic mutation has resulted in the UAC triplet changing to UAA (stop). This type of change is called a
a. missense mutation
b. nonsense mutation
c. antisense mutation
d. frameshift mutation
e. silent mutation

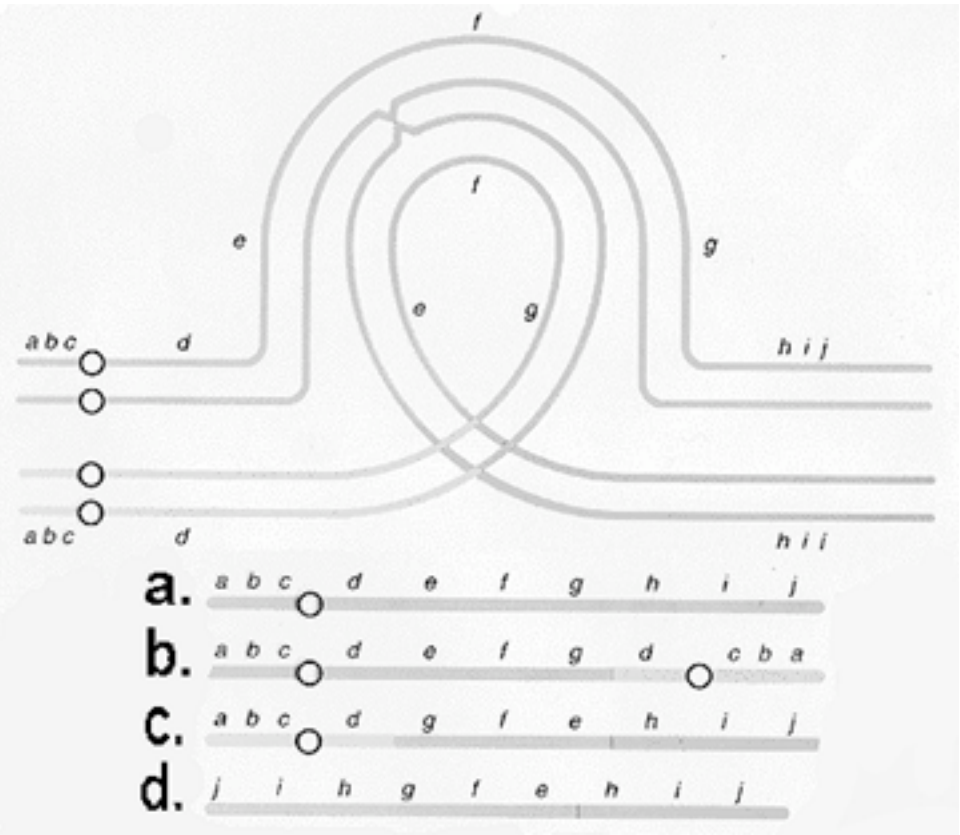
42. Happily for the cell in the previous question, (and strangely!), another mutation has occurred at a completely different gene! This one has altered the anticodon on a tyrosine-carrying tRNA to recognize and bind to UAA instead of UAC. The type of mutation that has resulted in the mutant tRNA is called a(n)
a. intragenic suppressor
b. physiological suppressor
c. missense suppressor
d. nonsense suppressor
e. SOS response

43. Repair enzymes which operate to correct mispairings during DNA replication are able to distinguish between template strand and newly manufactured strand because
a. the new strand runs antiparallel to the template strand
b. adenines are methylated on the template strand, but not on the newly made strand
c. the template strand has thymine dimers which serve as recognition points
d. intercalating agents in the DNA backbone act as coenzymes for repair enzymes
e. newly laid down bases are initially deaminated before replication is finished.

44. If a chemical mutagen causes a guanine or adenine to be broken away from the phosphodiester backbone of the DNA, leaving an empty space where the base would ordinarily be. This space is known as a(n)
a. SOS marker
b. apurinic site
c. apyrimidinic site
d. base analog site
c. deamination site

45. Which of the following isomers of DNA bases are the most common, and not very prone to mispairing errors during DNA replication?
a. enol form b. imino form c. keto form d. W-2 form

46. A non-lethal mutation that is dominant over the wild type allele of the same gene is
a. an essential mutation
b. a gain-of-function mutation
c. an indeterminate mutation
d. a silent mutation
e. none of the above



The figure above is a diagram of two homologous chromosomes at synapsis. Each homolog inherited from one of this moth's parents, and one of those parents seems to have undergone a mutation. Refer to the diagram to answer #47 - 50.

47. The unusual synaptic configuration is due to the fact that homolog Y is carrying
    a. a tranlocation mutation c. a supergene e. a grudge
    b. an inversion mutation d. a polytene chromosome

48. If a crossover takes place at the point marked with the two, touching "v" points, then the sister chromatid labeled "2" will be _____ after anaphase
    a. wild type c. dicentric e. two of the above
    b. acentric d. inviable

49. Which of the chromatids shown above will become the chromatid labeled "d"?
    a. 1 b. 2 c. 3 d. 4 e. not enough information given

50. In the individual showing the meiotic synapsis pattern above, what percentage of the gametes produced by meiosis are viable?
    a. 0% b. 25% c. 33% d. 50% e. 100%

If you're in a war, instead of throwing a hand grenade at some guys, throw one of those little baby-type pumpkins. Maybe it'll make everyone think of how crazy war is, and while they're thinking, you can throw a real grenade.

Deep Thoughts by Jack Handey

Okay, I promised. Here are some equations you might want to use.

Sum Rule = **(a/n) + (a/n) + (a/n)**...

Product Rule = **(a/n) x (a/n) x (a/n)...**

Binomial Theorem = $\mathbf{[n!/s!t!]\ (p)^s\ (q)^t}$

Coefficient of Coincidence = **observed crossovers/expected crossovers**

Chi Square = $\mathbf{\sum[(O-E)^2/E]}$ $_n$ with **df = n - 1**

Table 5-2

Critical Values of the χ^2 Distribution

df \ p	0.995	0.975	0.9	0.5	0.1	0.05	0.025	0.01	0.005	df
1	.000	.000	0.016	0.455	2.706	3.841	5.024	6.635	7.879	1
2	0.010	0.051	0.211	1.386	4.605	5.991	7.378	9.210	10.597	2
3	0.072	0.216	0.584	2.366	6.251	7.815	9.348	11.345	12.838	3
4	0.207	0.484	1.064	3.357	7.779	9.488	11.143	13.277	14.860	4
5	0.412	0.831	1.610	4.351	9.236	11.070	12.832	15.086	16.750	5
6	0.676	1.237	2.204	5.348	10.645	12.592	14.449	16.812	18.548	6
7	0.989	1.690	2.833	6.346	12.017	14.067	16.013	18.475	20.278	7
8	1.344	2.180	3.490	7.344	13.362	15.507	17.535	20.090	21.955	8
9	1.735	2.700	4.168	8.343	14.684	16.919	19.023	21.666	23.589	9
10	2.156	3.247	4.865	9.342	15.987	18.307	20.483	23.209	25.188	10
11	2.603	3.816	5.578	10.341	17.275	19.675	21.920	24.725	26.757	11
12	3.074	4.404	6.304	11.340	18.549	21.026	23.337	26.217	28.300	12
13	3.565	5.009	7.042	12.340	19.812	22.362	24.736	27.688	29.819	13
14	4.075	5.629	7.790	13.339	21.064	23.685	26.119	29.141	31.319	14
15	4.601	6.262	8.547	14.339	22.307	24.996	27.488	30.578	32.801	15

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