

This exam consists of multiple choice questions for junior level or higher University Students. They test knowledge of new terminology, manipulating classical genetic material, as well as molecular genetic developments. Many of the questions require actual diagramming the problem on scratch paper to obtain the correct answer.

1. An alternative form of a gene is
  - A. an allele.
  - B. a gamete.
  - C. a phenocopy.
  - D. a sibling.
  - E. variable expressivity.
  
2. Scientific method includes
  - A. selective use of criteria for "truth".
  - B. replication of experimental results.
  - C. observing, hypothesizing, and testing results.
  - D. a search for more inclusive theories.
  - E. all of the above.
  
3. Among others, Kölreuter and Von Gärtner established that
  - A. progeny are always intermediate between the parents.
  - B. chromosomes are the only constant predictable structures in the cell nucleus.
  - C. reciprocal crosses are generally equal.
  - D. pangenes develop an organ like the one from which the gemmule came.
  - E. acquired character result from a blending of blood of the parents.
  
4. Meiosis and mitosis have in common
  - A. synapsis of homologous chromosomes.
  - B. chiasma.
  - C.  $2n \rightarrow 1n$ .
  - D. maximum stainability of chromosomes in metaphase.
  - E. random assortment of chromosomes.
  
5. The siamang, Symphalangus syndactylus, has 50 chromosomes. The gibbon, Hylobates moloch, has 22 pairs of chromosomes (Myers and Shafer, 1977 Behavior Genetics 7th Annual Meeting). The hybrid has how many chromosomes?
  - A. 44
  - B. 47
  - C. 50
  - D. 72
  - E. 94
  
6. Globe-eyed goldfish, Carassius auratus, crossed with normal yielded an F<sub>2</sub> of 3/4 normal and 1/4 globe-eyed. The inheritance of the mutant fits a
  - A. dominant.
  - B. codominant
  - C. recessive.
  - D. dominant with reduced penetrance.
  - E. recessive with variable expressivity.

7. In Society finches a "fawn" colored bird crossed with a normal chocolate (dark) type yielded the F1 all chocolate. What fraction of the F2 would be expected to breed true?
- A. none
  - B. all
  - C.  $1/2$
  - D.  $1/3$
  - E.  $1/4$
8. The gray mutant in pigmented sheep, Ovis aries, is fully penetrant. About  $1/3$  (not  $1/4$ ) of the lambs one sees from gray x gray parents are non-gray. What frequency of the gray progeny are heterozygous?
- A. all.
  - B. none.
  - C.  $2/3$ .
  - D.  $1/2$ .
  - E.  $1/4$ .
9. Monozygotic twins have 100% concordance for manic depressive psychosis. Dizygotic twins have 25% concordance. Therefore, regarding the variation noted
- A. the genotype is mainly responsible.
  - B. the environment is mainly responsible.
  - C. both genotype and environment are important.
  - D. the data are inadequate for saying anything about the relative importance of genetics and environment.
  - E. identical twins have a higher frequency of such psychosis than the rest of the population.
10. Two mutants known for the guinea pig, Cavia porcellus, are white fur, a recessive, and rough (rosetted) coat, a dominant. Purebred stocks of each single mutant were crossed. What fraction of the F2 progeny are expected to be normal?
- A.  $1/16$ .
  - B.  $3/16$ .
  - C.  $9/16$ .
  - D.  $3/8$ .
  - E.  $1/4$ .
11. In the German cockroach, Blattella germanica, the mutants pallid eye and balloon wing are recessive, the mutant black body is codominant, and the mutant prowling is codominant (and lethal before classification when homozygous). From parents heterozygous for all 4 mutants the probability of getting normal progeny among survivors is
- A.  $3/64$ .
  - B.  $9/256$ .
  - C.  $9/128$ .
  - D.  $27/256$ .
  - E.  $27/192$ .

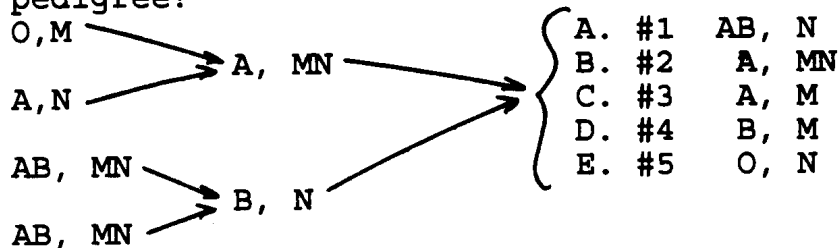
12. In the domestic ringneck dove, Streptopelia risoria, the purebred single mutant rosy stock was crossed to purebred single mutant albino stock (blocks all feather and eye pigment in the dove). Both mutants are recessive. Dark color = wild type.  
The ratio of dark to rosy to albino in that order in the F<sub>2</sub> should be:  
A. 12:3:1 B. 12:1:3 C. 9:6:1 D. 9:4:3 E. None of these
13. In the domestic ringneck dove, Streptopelia risoria, the purebred single mutant rosy stock was crossed to purebred single mutant albino stock (blocks all feather and eye pigment in the dove). Both mutants are recessive. Dark color = wild type.  
What fraction of the F<sub>2</sub> will not resemble either (one or the other) P<sub>1</sub> stock in color?  
A. 9/16 B. 7/16 C. 3/16 D. 1/4 E. None of these
14. In the domestic ringneck dove, Streptopelia risoria, the purebred single mutant rosy stock was crossed to purebred single mutant albino stock (blocks all feather and eye pigment in the dove). Both mutants are recessive. Dark color = wild type.  
What fraction of the F<sub>2</sub> normal class will breed true?  
A. 9/16 B. 1/3 C. 1/4 D. 1/9 E. 1/16
15. In the domestic ringneck dove, Streptopelia risoria, the purebred single mutant rosy stock was crossed to purebred single mutant albino stock (blocks all feather and eye pigment in the dove). Both mutants are recessive. Dark color = wild type.  
The F<sub>2</sub> would be expected to have:  
A. 3 phenotypes and 9 genotypes.  
B. 3 phenotypes and 16 genotypes.  
C. 4 phenotypes and 8 genotypes.  
D. 4 phenotypes and 9 genotypes.  
E. none of these.
16. The domestic dove, Streptopelia risoria, has 3 sex-linked alleles, D<sup>+</sup> (dark), d<sup>B</sup> (blond) and d<sup>w</sup> (white) in order of decreasing dominance. Which mating yields the greatest color variation in the progeny and yet allows the sex of each to be inferred by observing the color?  
A. D<sup>+</sup> d<sup>B</sup> x d<sup>w</sup>.  
B. D<sup>+</sup> d<sup>w</sup> x d<sup>B</sup>.  
C. d<sup>B</sup> d<sup>w</sup> x D<sup>+</sup>.  
D. d<sup>B</sup> d<sup>w</sup> x d<sup>w</sup>.  
E. d<sup>w</sup> d<sup>w</sup> x d<sup>B</sup>.

17. The gazzi pattern in Modena pigeons is white on the neck, breast and ventral surface. It is a genetic recessive to self (solid) color. White in runt pigeons is also a genetic recessive. A white runt crossed with a Modena gazzi yielded an intermediate F1 and an F2 consisting of 9 gazzi, 15 intermediates and 12 white offspring. Therefore,
- A. this may be a 1:2:1 ratio.
  - B. the mutants are alleles.
  - C. they are non-alleles, since recessives cannot yield 3 F2 mutant phenotypes.
  - D. they are non-alleles interacting without recovery of wild type.
  - E. both A and B are correct.
18. Barking while trailing is controlled by a dominant gene in dogs, the homozygous recessive normal being silent. An F2 litter of 5 pups raised would have what probability that at least three were barkers?
- A. 1/2
  - B. 297/512
  - C. 459/512
  - D. 675/1024
  - E. 81/128
19. A prairie flower, Liatris cylindracea, is self incompatible. The corms may live to over 44 years and can be "aged" by annual pigment rings. The surviving older plants are more heterozygous for 12 allozyme systems than younger plants. Among 2 year olds, those that flower in season are more heterozygous than non-flowering ones (Schaal & Levin, 1976, Amer. Nat. 110: 191-206). This is a good example in a natural population of
- A. founder effect.
  - B. genetic drift.
  - C. heterozygote advantage.
  - D. inbreeding.
  - E. Hardy-Weinberg population equilibrium.
20. The Hardy-Weinberg formula  $p + q = 1$  does not directly fit
- A. gene frequencies.
  - B. gametic frequencies.
  - C. frequencies in diploids.
  - D. frequencies in haploids.
  - E. frequencies in the hemizygotic sex.
21. Baldness in humans is sex-influenced, baldness being dominant in men. If 8% of the women are near bald, what is the expected frequency of bald men in the population?
- A. 8%
  - B. 28%
  - C. 40%
  - D. 48%
  - E. 72%

22. 36% of the Carib Indians have the Diego blood factor (which is practically confined to the Mongolian races). A Carib tribe of 350 persons would be expected to have about how many homozygotes for the Diego factor?
- A. 14
  - B. 56
  - C. 70
  - D. 126
  - E. none of these.

23. A rare self sterile flower imported with difficulty is being propagated. A particular weak stem character controlled by a recessive gene is undesirable and completely culled. If the frequency of weak stem is currently 1/25 in the population, how many generations will it take to reduce the frequency to a commercially acceptable 1%?
- A. 75
  - B. 25
  - C. 10
  - D. 5
  - E. 1

24. Which grandchild qualifies in the following blood type pedigree?



25. If a c indicates one single crossover class in a trihybrid testcross of linked genes, then its reciprocal class is
- A. a
  - B. b
  - C. b c
  - D. a b
  - E. a b c

26. Satin and beige are linked recessive mutants in the mouse, Mus musculus. A testcross of progeny from a cross of the purebreeding mutant strains yielded the data below. How far apart are the two genes?

42 beige  
 48 satin  
 3 satin-beige  
7 normal

- A. 90 map units.
- B. 45 map units.
- C. 10 map units.
- D. 3/7 map units.
- E. none of these.

27. If testcross results included 16% of the progeny with the genotype A M, what was the linkage phase of the F1?

- A.  $\frac{A \quad M}{+ \quad +}$                       D.  $\frac{A(M) \quad +}{+ \quad +}$
- B.  $\frac{A \quad +}{+ \quad M}$                       E.  $\frac{A \quad M}{A \quad M}$
- C.  $\frac{A \quad +}{M \quad +}$

28. In male pigeons the autosomal gene S, controlling the spread pattern, shows 50% crossing over with o, which controls opal color. The locus for the multiple allelic series c, +, C, C(T) controlling barless, bar, check, and T-pattern is 45 units from S and 7 units from o. The gene order is

- A. S-C-o.  
 B. C-S-o.  
 C. C(T)-o-S.  
 D. S-o-C.  
 E. o-S-c.

29. An "F factor" plasmid is directly involved in

- A. transformation.  
 B. "sexduction" during bacterial conjugation.  
 C. recombination in phages.  
 D. transduction.  
 E. lysogenic Salmonella.

30. If crossing over is suppressed in one chromosome pair, one suspects a heterozygous

- A. deficiency.  
 B. duplication.  
 C. inversion.  
 D. mutation.  
 E. translocation.

31. The duplication and/or deletion of genetic material may result from

- A. unequal crossing over.  
 B. non-disjunction.  
 C. breakage-fusion-bridge cycle.  
 d. heterozygous reciprocal translocation with adjacent centromeres going to the same pole.  
 e. any or all of these.

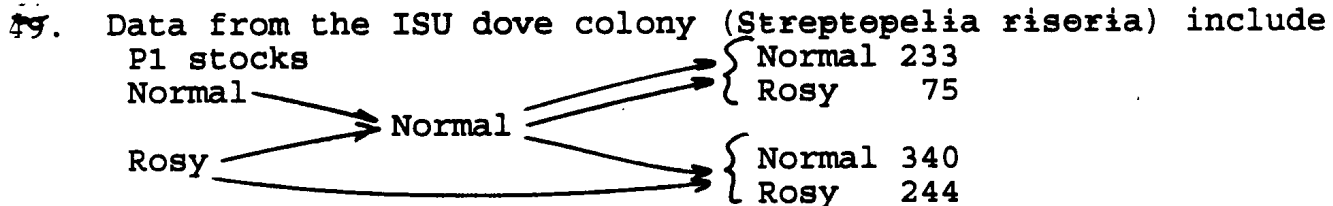
32. The synaptic figure of a heterozygous inversion within an inversion would be shaped like
- a cross.
  - a circle.
  - a bridge.
  - a figure 8.
  - none of these.
33. An XXXXY Klinefelters Syndrome would have how many Barr bodies?
- No Barr bodies
  - One Barr body.
  - Two Barr bodies.
  - Three Barr bodies.
  - Four Barr bodies.
34. An "easy" and useful way for horticulturists to obtain plants with seedless fruits is to
- use X-rays to induce sterility.
  - cross a tetraploid with a diploid.
  - make a heterozygous translocation.
  - make a trisomic aneuhexaploid.
  - induce scar tissue.
35. A mutant phenotype from a genetic cause can occur even if all genes are normal when
- the organism is an aneuploid.
  - the organism has a duplication.
  - the organism is a nullosomic.
  - the organism is a trisomic.
  - any of the above answers is correct.
36. Tryptophan (T), an amino acid, must be supplied in the diet of Drosophila melanogaster. The autosomal mutant cinnabar eye color (cn) also "causes" an accumulation of kynurenine (K) but if xanthommatin (X) is added, the eyes are the normal red. The sex-linked mutant vermilion eye color (v) also "causes" an accumulation of tryptophan; but if kynurenine or xanthommatin is added, the normal eye color results. The order of synthesis and the position of the mutant blocks is
- K--cn--> X--v--> T
  - X--cn--> T--v--> K
  - T--v --> K--cn--> X
  - K--cn--> T--v--> X
  - X--v --> K--cn--> T
37. DNA (is)
- a double helix.
  - deoxyribose nucleic acid.
  - a polymeric molecule containing a series of nucleotides.
  - contains sugar + nitrogenous base + "phosphoric acid"
  - all of the above.



38. DNA structure is monotonous in all ways except
- A. the covalent bonding of the phosphorus unit with the sugar.
  - B. the covalent bonding of ribose with the purines.
  - C. the linear order of organic bases.
  - D. the phosphorus bonding the purines and pyrimidines together as "rungs".
  - E. pairing of the organic bases with each other.
39. DNA replication is not
- A. bidirectional.
  - B. discontinuous.
  - C. conservative.
  - D. 5' ---> 3' in addition of nucleotides.
  - E. "proofread".
40. In the transcription process ATG would control the RNA
- A. UAC
  - B. TAG
  - C. GTC
  - D. TAU
  - E. CGA
41. Palindromes of organic base sequences are
- A. processed introns.
  - B. poly-A tails to bind mRNA to the endoplasmic reticulum.
  - C. terminators of transcription.
  - D. promoters of transcription.
  - E. promoters of translation.
42. Transcription is (or includes)
- A. terminated by telomeres.
  - B. controlled by DNA dependent RNA polymerase.
  - C. non-linear.
  - D. pairing of RNA bases of any 2-ring structure with any RNA base of 1-ring structure.
  - E. the production of amino acid strings.
43. Feed back inhibition, induction, repression, promoters, operators...are all terms dealing with examples of
- A. gene regulation.
  - B. the Muller-5 model of calculating mutant frequencies.
  - C. DNA replication.
  - D. translation.
  - E. vertebrate exon production.
44. A frame shift results in
- A. a mutation.
  - B. a translocation between chromosomes.
  - C. a deletion.
  - D. genetic drift.
  - E. Tay-Sachs syndrome.

45. Kappa is  
 A. a bacteria-like factor in paramecia producing a substance that kills non-kappa paramecias.  
 B. a plasmid in E. coli.  
 C. an endosymbiont in chloroplasts.  
 D. a cause of cytoplasmic male sterility in corn.  
 E. a cause of poky-heterokaryons in Neurospora.
46. The type of enzyme which cuts specific sequences of DNA is a  
 A. protease  
 B. Helicase  
 C. gyrase  
 D. ligase  
 E. Restriction endonuclease
47. A change in gene linkage relationships is not expected with a(n)  
 A. deletion.  
 B. duplication  
 C. inversion.  
 D. translocation.  
 E. Turner's syndrome.
48. Heterozygotes can breed true (one phenotype and only that phenotype seen generation after generation)  
 A. when heterosis is involved.  
 B. when the parent stocks are purebred.  
 C. when a balanced lethal exists.  
 D. when codominant lethals are allelic to each other.  
 E. never.

~~In the rosy dove problem above~~



- The X<sup>2</sup> values for the F<sub>2</sub> and the testcrosses respectively are  
 A. about 0.07 and 15.78 .  
 B. about 6.9 and 1.58 .  
 C. about 0.7 and 1.58 .  
 D. both excessively high.  
 E. both too low to need to calculate.

50. In the rosy dove problem (49),
- the F2 and testcross data support the hypothesis of a simple monohybrid recessive for rosy.
  - the P is  $> 0.05$  for the F2, but  $< 0.05$  for the testcross data.
  - one should reject the monohybrid hypothesis regarding F2 results, but accept the testcross results.
  - when one parent is rosy, rosy offspring survive better than normals.
  - heterozygous parents raise normal progeny OK, but evidently more rosy offspring die off selectively before classification in the F2.

$$p + q = 1$$

$$\frac{n!}{s! t!} p^s q^t$$

$$X^2 = \sum \frac{d^2}{e}$$

$X^2$  value for 5% level of significance  
 for 1 df = 3.84  
 2 df = 5.99  
 3 df = 7.82  
 4 df = 9.48  
 5 df = 11.07

$$\frac{1}{(x + g)^2}$$