

Part 1. Matching. In the numbered questions (on the left), chose the BEST possible answer from the ones given by the letters (on the right). Not all answers are used, and some answers might be used more than once. Two points each. Total 30 points

1. ___s___ is the relationship among repeated parts of a single organism arrayed along the body axis.
 2. ___g___ are genes that regulate the overall body plan and determine the number, identity and pattern of body parts.
 3. ___p___ isolating mechanisms reduce the survival or reproduction of hybrids produced when different species mate.
 4. Speciation that requires geographic isolation is known as ___a___ speciation.
 5. Variation in an organism's phenotype due to variation in the ___b___ is known as phenotypic plasticity.
 6. Sexual selection via mate choice is called ___k (or j)___ selection.
 7. Use of antibiotics often results in the rapid evolution of ___r___.
 8. If the dominance relationships among alleles at a single locus depend on the sex of the individual, the trait is ___t___.
 9. Siamese coloration in cats is due to a(n) ___v___ gene.
 10. An XXY fruit fly with a normal set of autosomes is what gender? ___c___.
 11. /12. A human with a karyotype described as 47, XXY is ___n___ (gender) and suffers from ___m___.
 13. A(n) ___i___ gene is one for which only the allele inherited from one sex is expressed.
 14. The region of the Y chromosome that contains genes homologous to genes on the X is called the ___q___.
 15. A 3 base-pair repeats that undergo expansion after reaching a pre-mutation stage characterizes what genetic disorder? ___d (or h)___
- a) allopatric
 - b) environment
 - c) female
 - d) Fragile-X syndrome
 - e) genetic anticipation
 - f) genotype
 - g) homeotic genes
 - h) Huntington Disease
 - i) imprinted
 - j) intersex
 - k) intersexual selection
 - l) intrasexual selection
 - m) Klinefelter Syndrome
 - n) male
 - o) premating
 - p) postmating
 - q) pseudo-autosomal region
 - r) resistance
 - s) serial homology
 - t) sex-influenced
 - u) sympatric
 - v) temperature sensitive
 - w) Turner Syndrome
 - x) X-chromosome region
 - y) X-linked

Part 2. Multiple Choice Questions. Pick the BEST answer among the choices given. 16 Questions, 4³/₈ points each.

A. EVOLUTION

1. The major differences in body plans among organisms are the result of
 - a) major changes in the structural genes
 - b) changes in the genetic regulatory hierarchy**
 - c) serial homology
 - d) an increase in genome complexity
 - e) horizontal transmission

 2. Segment polarity genes in animals are examples of
 - a) Hox genes**
 - b) MADS box genes
 - *c) tagmosis genes
 - d) insect-specific genes
 - e) none of the above
- * also accepted
3. Two groups of flies in the genus *Eurosta* feed on two different species of goldenrod flowers that grow side by side in the same environment. Each group of flies is genetically distinct from the other and is adapted to the chemistry of one of the two goldenrod species. As a result, each group of flies is very faithful to its host plants and is almost never found anywhere else. When flies from the two groups are placed together they usually mate. The offspring can survive on both host plants but not as well as members of either parent group. What is the best explanation for how these two groups of insects are becoming reproductively isolated when they occur side by side in the same environment?
 - a) Because individuals are restricted to their host plants, the two groups of flies are physically isolated (although living in the same area)**
 - b) Natural selection is so strong that isolation has occurred almost instantly
 - c) The two groups of flies speciated at the same time as the plants because of a change in chromosome number
 - d) The two groups are not becoming reproductively isolated because they can mate in the lab
 - e) This is an example of allopatric speciation

 4. Which of the following is not a postulate of Darwin's theory of evolution by natural selection?
 - a) Traits show phenotypic variation in a population
 - b) The phenotypic variation can be caused by genes or by the environment**
 - c) The phenotypic variation can be passed from parent to offspring
 - d) Some individuals in a population are better able to survive and reproduce than others
 - e) Survival and reproduction are not random, but are dependent on the phenotypic variation among individuals

5. On the Galapagos Island of Daphne Major, finches evolved larger beaks in response to a drought. Which of the following is a necessary condition for the evolutionary response (beaks getting larger) to the change in the environment?

- a) finch beaks exhibit phenotypic plasticity
- b) the finch population size is very small and isolated
- c) finch beak size is an inherited characteristic**
- d) all finch beak sizes have the same effect on survival and reproduction
- e) none of the above

6. Male blackbirds vigorously defend their territories against other males. Male mating success is generally determined by the quality of the male's territory, rather than by female preferences for male traits. This mating system is most likely the result of

- a) Intrasexual selection**
- b) Intersexual selection, direct benefits
- c) Intersexual selection, indirect benefits, "good genes"
- d) Intersexual selection, indirect benefits, Fisher's "runaway"
- e) None of the above

7. Dance flies (Empidids) mate in swarms and females mate only with males that present them with a nuptial gift (generally a dead insect wrapped in silk). Females that receive larger gifts lay more eggs. Which model of the sexual selection best explains nuptial gifts in these insects?

- a) Intrasexual selection
- b) Intersexual selection, direct benefits**
- c) Intersexual selection, indirect benefits, "good genes"
- d) Intersexual selection, indirect benefits, Fisher's "runaway"
- e) None of the above

8. Under which circumstances should HIV evolve to become less virulent (i.e. less likely to kill its host)?

- a) If transmission between hosts is common
- b) If transmission between hosts is rare**
- c) If the mutation rate is low
- d) If the mutation rate is high
- e) none of the above

B. GENETICS

9. Two organisms, AABBCCDDEE and aabbccdde, are mated to produce an F1 which is then self-fertilized. If the capital letters represent dominant, independently assorting alleles, what proportion of the F2 genotypes will be recessive for all five loci?

- a) 0
- b) 1/64
- c) 1/32
- d) 1/16
- e) **none of the above (correct answer is 1/1024)**

10. In some plants, a red pigment (cyanidine) is synthesized from a colorless precursor. The addition of a hydroxyl group to the cyanidine molecule causes it to become purple. In a cross between two purple plants, the following results are obtained: 94 purple; 31 red; 43 colorless. Of the following list, what were the most likely genotypes of the parental purple plants?

- a) Aa and Aa
- b) AA and aa
- c) Aa and aa
- d) AABB and aabb
- e) AAbb and aaBB
- f) **AaBb and AaBb**

*11. A bell pepper plant producing yellow peppers was crossed to a plant producing brown peppers, and all the F1 offspring plants produced red peppers. These F1 plants were crossed to each other and in the F2 produced 85 with red peppers, 35 with yellow peppers, 25 with brown peppers and ~~40~~ 15 with green peppers. The results of a chi-square test of the hypothesis that pepper color is determined by two independently assorting genes, each with two different alleles, would yield the following results:

- a) $\chi^2=0.03$, $df=1$, $P>0.90$
- b) $\chi^2=4.44$, $df=1$, $0.01<P<0.05$
- c) $\chi^2=0.00$, $df=3$, $P>0.9$
- d) $\chi^2=0.03$, $df=3$, $P>0.90$
- e) **$\chi^2=4.44$, $df=3$, $0.20<P<0.50$**

*Because of a typo in the problem, none of the choices given are correct. So everyone received full credit for this problem. (e) is the correct answer for the problem when there are 15 (rather than 10) green peppers.

12. Assume that bell pepper color results from the interactions of two different genes. One gene determines whether red (genotype $R-$) or yellow (genotype rr) pigment will be produced. The other gene determines whether chlorophyll will be produced. If green peppers result from the presence of yellow pigment and the presence of chlorophyll, then which of the following is most likely to be true.

- a) **a recessive allele at the second locus causes the production of chlorophyll**
- b) a dominant allele at the second locus causes the production of chlorophyll
- c) red peppers have both red pigment and chlorophyll
- d) both yellow and brown peppers have chlorophyll
- e) brown peppers do not have either yellow or red pigment

13. In humans, there is a dominant allele that causes vitiligo, where small-unpigmented spots appear on the body. Also, there is a recessive allele for another gene that causes albinism, which causes the entire body to be unpigmented. Vitiligo cannot be seen in albinos. A man with vitiligo had an albino mother and normal father. If the man has a child by a phenotypically normal skinned woman who had an albino father, what is the probability of having a phenotypically normal child?

- f) 0
- g) 1/8
- h) 1/4
- i) 1/2
- j) none of the above (correct answer is 3/8)**

14. What is the most likely explanation for finding that a sterile man that is otherwise phenotypically normal has 46 chromosomes and a sex-chromosome karyotype of XX?

- a) he has Klinefelter syndrome
- b) he has Turner syndrome
- c) his Y chromosome is missing the SRY gene
- d) he has a copy of the SRY gene on an autosome**
- e) he has two Y chromosomes

15. Determining the sex of chicks is difficult without sacrificing them, but seeing whether or not they have the barred or non-barred feather color pattern is easy. Making use of the fact that barred is a sex-linked (Z-linked) dominant, choose a cross that would allow you to identify the sex of chicks.

- a) Heterozygous barred female x Hemizygous nonbarred male
- b) Hemizygous barred male x Homozygous nonbarred female
- c) Heterozygous barred male x Hemizygous nonbarred female
- d) Homozygous barred male x Hemizygous nonbarred female
- e) Hemizygous barred female x Homozygous nonbarred male**

16. How many Barr bodies would one expect to see in cells of Turner syndrome females (karyotypically 45,X0) and double-Y male (karyotypically 47,XYY)?

- a) 0,0**
- b) 0,1
- c) 0,2
- d) 1,0
- e) none of the above

Formulae, etc.

χ^2 Test:
$$\chi^2 = \sum \frac{(O-E)^2}{E}$$

χ^2 Table

| Probabilities | | | | | | |
|---------------|-------------|-------------|-------------|-------------|-------------|--------------|
| df | 0.90 | 0.50 | 0.20 | 0.05 | 0.01 | 0.001 |
| 1 | 0.02 | 0.46 | 1.64 | 3.84 | 6.64 | 10.83 |
| 2 | 0.21 | 1.39 | 3.22 | 5.99 | 9.21 | 13.82 |
| 3 | 0.58 | 2.37 | 4.64 | 7.82 | 11.35 | 16.27 |
| 4 | 1.06 | 3.36 | 5.99 | 9.49 | 13.28 | 18.47 |