

EBIO 2070 EXAM 1 SPRING 2010

Name \_\_\_\_\_ KEY \_\_\_\_\_

SHOW YOUR WORK

Section, TA \_\_\_\_\_ ALL \_\_\_\_\_

1. (6 points). Alkaptonuria is a rare disease caused by an autosomal recessive allele of a single gene. What is the chance that a normal woman whose uncle had the disease is heterozygous for the disease allele?

The woman's grandparents must each be Aa to be unaffected and produce an aa child (the uncle). The woman's parent from outside the affected family is AA and for the woman to be heterozygous, her other parent must be Aa.  
 Prob (woman is Aa) = Prob (normal parent = Aa from Aa x Aa) x Prob (Aa x AA produces Aa)  
 = 2/3 x 1/2 = 1/3

2. (4 points). In a natural population of annual plants, a single plant is found that is sickly looking and has yellowish leaves. The plant is dug up and brought back to the laboratory. Photosynthesis rates are found to be very low. Pollen from a normal dark green-leaved plant is used to fertilize flowers of the yellow plant. A hundred seeds result, of which only 60 germinate. All the resulting plants are sickly yellow in appearance. Propose a genetic explanation for the inheritance pattern.

The sickly plant has a mutation in its chloroplast DNA

3. (15 points total; 5 points each). The pedigree below shows the pattern of inheritance of webbed toes in a family, which appears to be inherited as an autosomal dominant. Give one piece of evidence to eliminate each of the following patterns of inheritance.

a) Y-linked.

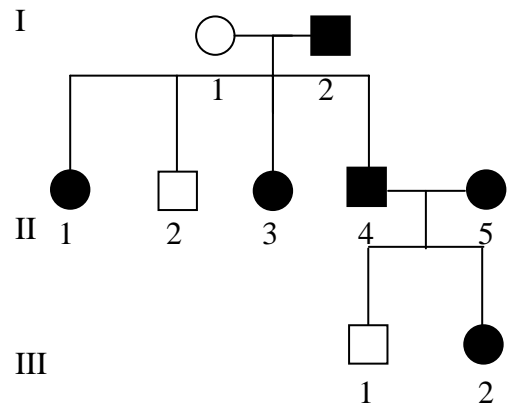
females should not have the trait;  
 II-2 and III-1 should have received the trait from their fathers

b) X-linked recessive.

All sons of an affected mother should exhibit the trait;  
 II-5 and III-1 violate this rule

c) X-linked dominant.

An unaffected mother cannot have an affected son; I-1 and II-4 violate this rule



4. (5 points). Which of your parents and grandparents are expected to have virtually the same mitochondrial DNA sequence as you? Be sure to identify grandparents as maternal or paternal, grandmother or grandfather.

mother and maternal grandmother

5. (18 points total). In peas, yellow cotyledon color is dominant to green, and inflated pod shape is dominant to the constricted form. When both of these traits were considered in self-fertilized dihybrids, the progeny appeared in the following numbers: 193 green, inflated: 184 yellow, constricted: 556 yellow, inflated: 61 green, constricted.

a) (4 points). What numbers of each of the four phenotypic categories are expected if the genes assort independently?

$$9/16 \times 994 = 559.1 \text{ yellow inflated}$$

$$3/16 \times 994 = 186.4 \text{ green inflated}$$

$$3/16 \times 994 = 186.4 \text{ yellow constricted}$$

$$1/16 \times 994 = 62.1 \text{ green constricted}$$

b) Use the Chi-square test to determine whether the observed results differ significantly from those expected, assuming independent assortment. (NOTE THE USEFUL INFORMATION ON THE LAST PAGE). In conducting the test, provide answers to the following questions:

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

$$= (556-559.1)^2/559.1 + (193-186.4)^2/186.4 + (184-186.4)^2/186.4 + (61-62.1)^2/62.1$$

$$= 9.61/559.1 + 43.56/186.4 + 5.76/186.4 + 1.21/62.1$$

$$= 0.0172 + 0.2337 + 0.0309 + 0.0195 = 0.301$$

(2 points). How many degrees of freedom are there? 3

(9 points). What is the value for Chi-square? 0.301

(3 points). Should you reject the hypothesis of independent assortment of two genes? no, p>0.95

6. (9 points total). Chimpanzees have 48 chromosomes in their diploid cells. How many chromosomes AND chromatids are present at each of the following stages of nuclear division?

a) (3 points). G<sub>2</sub> of mitotic interphase

2n, 4C = 48 chromosomes, 96 chromatids

b) (3 points). metaphase II of meiosis

1n, 2c = 24 chromosomes, 48 chromatids

c) (3 points). anaphase of mitosis (consider the structure at this stage to be one cell)

4n, 4c = 96 chromosomes, 96 chromatids

7. (10 points total). In peas, purple flowers are dominant to white flowers and long stems are dominant to short stems. These differences in flower color and stem length are each controlled by single genes that assort independently. A true-breeding line with purple flowers and short stems is crossed to a true-breeding line with white flowers and long stems. The resulting F<sub>1</sub> is then test-crossed. List the phenotypes expected in the offspring of the test cross and indicate for each whether it is parental or recombinant.

purple, long stem - recombinant

purple, short stem - parental

white, long stem - parental

white, short stem - recombinant

8. (8 points total; 4 points each). A diploid zebrafish is produced by suppressing meiosis II in an egg, so that the sister chromatids divide but stay in the same cell.

a) Is the resulting individual genetically identical to the female that produced the egg? Why or why not?

no; for many genes, segregation has occurred in meiosis I, so that only the mother's paternally-derived allele or maternally-derived allele is present in the offspring

b) Is the resulting individual expected to be homozygous for all of its genes? Why or why not?

no; because of crossing-over in meiosis I, the sister chromatids that normally separate in meiosis II are not identical

9. (5 points total; 2.5 points each). For a certain gene in a diploid organism, eight units of protein product are needed for normal function. Each wild-type allele produces five units of this protein.

a) Is this gene haplosufficient or is it haploinsufficient?

haploinsufficient

b) Will a null (non-functional) allele be dominant or will it be recessive?

dominant

10. (20 points total; 2 points each). Fill in the blank.

a) The molecular assemblage that facilitates pairing of dyads during prophase I is referred to as a synaptonemal complex.

b) The type of variation illustrated by human skin color is referred to as continuous or quantitative variation.

c) The two members of a chromosome pair in a diploid nucleus carry the same genes in the same relative positions and are referred to as homologous chromosomes.

d) A single cell with a mixture of organelle genotypes is referred to as a cytohet.

e) In humans, females have two morphologically similar sex chromosomes and are therefore referred to as the homogametic sex.

f) Offspring that are recombinant for two genes on the same chromosome are produced by the process of crossing over.

g) The Y-linked gene that determines maleness in humans is SRY.

h) A cell in a diploid organism at anaphase II of meiosis has a chromosome complement of 2 n and a DNA content of 2 C.

i) Spores in plants are produced by the nuclear division process of meiosis.

Extra Credit (2 points). How are the traits that were studied by Mendel different from those that were of most interest to Charles Darwin?

Mendel studied discrete (discontinuous) traits; Darwin was interested in continuous variation

## POTENTIALLY USEFUL INFORMATION

df	Probabilities									
	0.95	0.90	0.70	0.50	0.30	0.20	0.10	0.05	0.01	0.001
1	0.004	0.016	0.15	0.46	1.07	1.64	2.71	3.84	6.64	10.83
2	0.10	0.21	0.71	1.39	2.41	3.22	4.61	5.99	9.21	13.82
3	0.35	0.58	1.42	2.37	3.67	4.64	6.25	7.82	11.35	16.27
4	0.71	1.06	2.20	3.36	4.88	5.99	7.78	9.49	13.28	18.47
5	1.15	1.61	3.00	4.35	6.06	7.29	9.24	11.07	15.09	20.52
6	1.64	2.20	3.83	5.35	7.23	8.56	10.65	12.59	16.81	22.46

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