Genome 371; A 03
Berg/Brewer
Practice Exam I KEY; Wednesday, Oct 15, 2003

1) (16 pts) You are studying plant height in a new strain of peas. You let a plant of moderate height self pollinate and grow up the progeny of this cross. You discover the following heights and numbers among the 96 offspring of the self-cross:

19 Tall 54 Moderate 23 Dwarf

A) If this trait were determined by a single gene, what genetic principle does this cross illustrate?

Incomplete dominance

What is the expected ratio for this hypothesis? **1:2:1**

Give the genotype of the moderate plant and possible genotypes for the offspring.

Moderate Parent: **Tt**

Offspring: Tall: **TT** Dwarf: **tt**

B) If this trait were determined by two genes, what genetic principle does this cross illustrate?

epistasis

What is the expected ratio for this hypothesis? **9:3:4**

Give the genotype of the moderate plant and possible genotypes for the offspring.

Moderate Parent: **Aa Bb**

Offspring: Tall: **aa B- (aa BB or aa Bb)** Dwarf: **- - bb (AA bb, Aa bb, or aa bb)**

C) Below are the X^2 values for each hypothesis. What are the P values for each hypothesis? Is either hypothesis rejected by the data? (A X^2 table is on the cover page of the exam.)

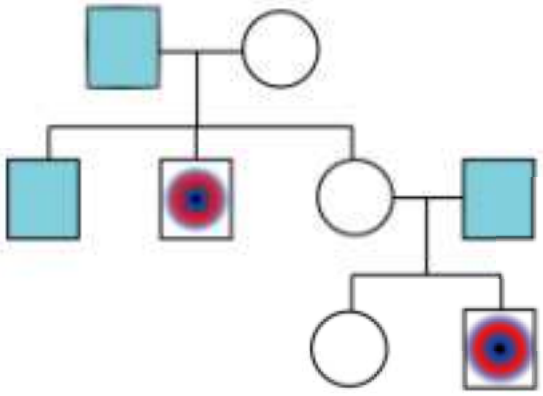
Hypothesis	X^2 value	P value	Accept/Reject?
"one" gene	1.83	between **0.5** and **0.1**	**Accept**
"two" genes	0.097	between **0.975** and **0.9**	**Accept**

D) What experiment would you do to distinguish between the two hypotheses? Include the expected results. **Many possible experiments.**

One example: Cross Tall x Tall. If hypothesis 1, all Tall (TT).
If hypothesis 2, could obtain some dwarf.

Genome 371; A 03
Berg/Brewer
Practice Exam I KEY; Wednesday, Oct 15, 2003

2) (12 pts) There are two sex-linked traits segregating in the family shown below. (The pedigree is repeated below for your convenience.) For this question, ignore complications arising from biased X-chromosome inactivation.



A). Is  a dominant or recessive trait? **recessive**

Use X^A and X^a to indicate genotypes for this trait. What is the genotype of  ? **X^a Y**

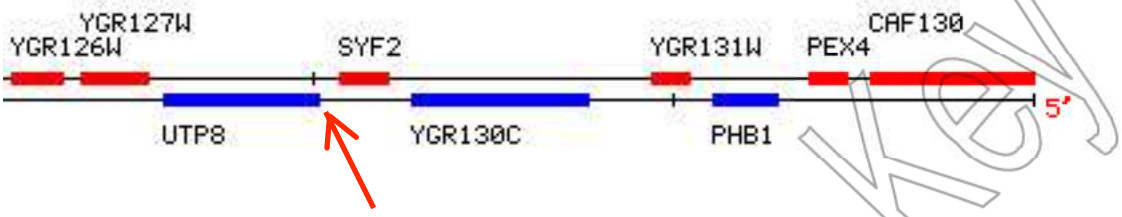
B) Is  a dominant or recessive trait? **recessive**

Use X^B and X^b to indicate genotypes for this trait. What is the genotype of  ? **X^b Y**

C) Assume the A and B loci are closely linked to one another. What is the genotype of III-1?

$X^{b\ A}$ from Dad, $X^{a\ B}$ from Mom

3) (7 pts) Below is a portion of the yeast genome as displayed in the Saccharomyces data base (SGD). The gene of interest is UTP8. Deduce the answers to the following questions about this gene by looking at this diagram.



A. What would be the systematic name of UTP8? **YGR128C**

B. What chromosome is UTP8 on? **VII (7)**

C. In which direction from UTP8 (left or right) would the centromere be found? **left**

D. On which side of UTP8 (left or right) would you find UTP8's promoter? **right**

E. In what direction (left or right) would RNA polymerase move to make UTP8 mRNA? **left**

F. Which strand (watson or crick) would RNA polymerase use as template to make the message for UTP8?

watson

G. On the map above draw an arrow to the specific place where the ATG codon for UTP8 would be found.

4) (25 pts) Wanting to follow in Beadle and Tatums's footsteps, Sue decided to genetically dissect the pathway of vitamin B12 synthesis in her favorite haploid organism, yeast.

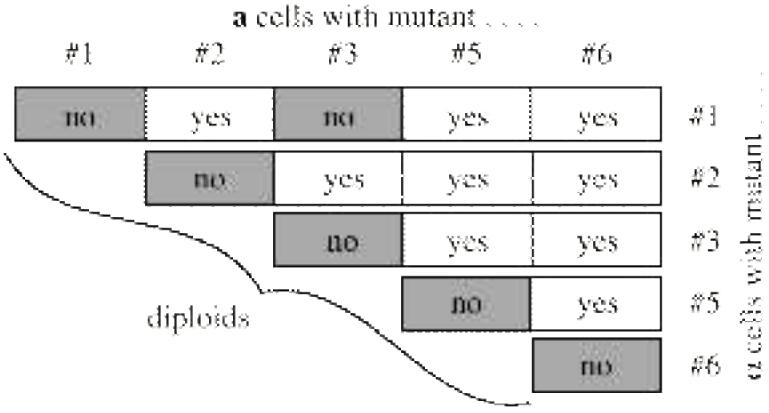
First she isolated lots of mutants (6 mutants) that all required vitamin B12 to be present in the medium in order for the cells to grow. Then she crossed them all individually to wild type yeast and plated on plates that lacked vitamin B12. Here are her results:

haploid mutant number	growth of heterozygous diploid without B12?
#1	yes
#2	yes
#3	yes
#4	no
#5	yes
#6	yes

A. What did these results tell Sue about each of her mutants?

Mutants 1, 2 , 3, 5 and 6 are recessive to their wild-type alleles. Mutant 4 is dominant to the wild-type allele. All of the mutants are apparently loss-of-function mutations.

Sue then crossed some of her mutants in pair-wise combinations and tested their growth on -B12 plates. Here are her results: ("yes" and "no" refer to whether the diploid was able to grow in the absence of vitamin B12.)



B. What did these results tell Sue?

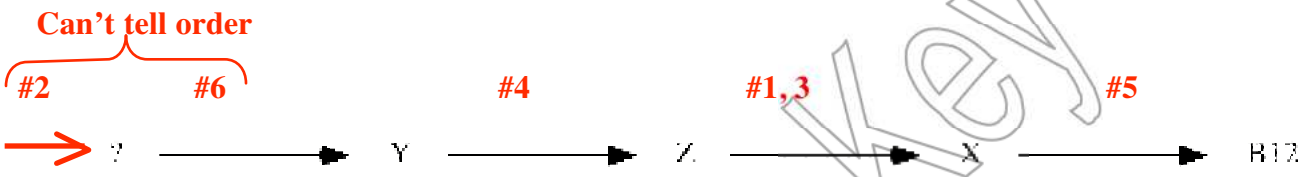
Mutations 1 and 3 are in the same gene. Mutations 2, 5 and 6 define different genes.
1 and 3 fail to complement.
The other three alleles complement each other and also 1 and 3.

Sue then tried growing her 6 different mutants on plates that lacked vitamin B12 but contained one of several different intermediates in the B12 pathway. She called them compounds X, Y and Z.

	growth on medium lacking vitamin B12 but containing		
cells with mutant	X	Y	Z
#1	yes	no	no
#2	yes	yes	yes
#3	yes	no	no
#4	yes	no	yes
#5	no	no	no
#6	yes	yes	yes

C. Sue's biochemist friend said that the intermediates are converted into vitamin B12 in the order shown below. Do Sue's mutant data support the biochemist's hypothesis?

Yes___ No ___ Not exactly **X**



If **yes**, indicate on the pathway above, the steps catalyzed by each of the gene produces (1-6) identified by Sue.

If **no**, draw your own pathway.

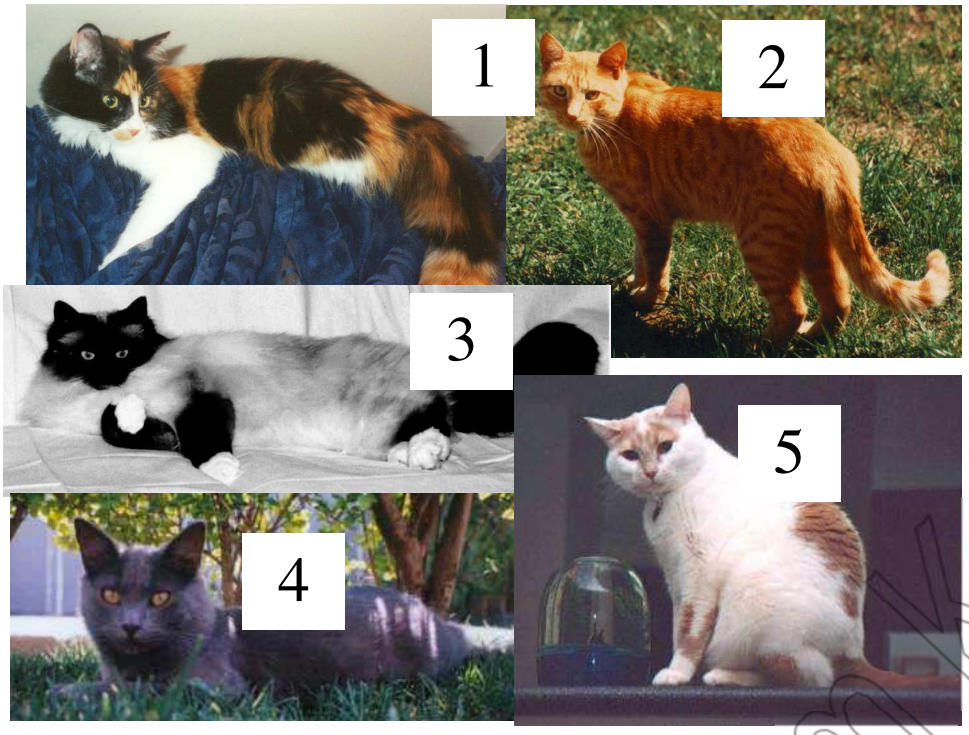
If **not exactly**, where do the biochemical and genetic data disagree? How would you modify the biochemist's hypothesis? Answer these questions and then modify the diagram above to reflect this change. Are there still unresolved issues about the pathway? If so, what are they.

There are at least two steps to synthesize Y, but we can't tell which one acts earlier in the pathway. We need to identify substance "?"and test #2 and #6 for growth on that compound.

D. What specific hypothesis can you make about the structure of the enzyme encoded by the gene that is mutant in strain #4?

The enzyme encoded by the wt gene that has been mutated in strain 4 is composed of subunits that must assemble to create a functional enzyme.

6) (20 pts) Assume all of the cats in the composite photo are homozygous **UNLESS** there is something about their appearance that would lead you to believe otherwise. Further assume that you would have access to cats of either sex for each type, **UNLESS** there is something about their appearance that would lead you to believe otherwise.



Phil wants to generate a male cat that is a long-haired Siamese with orange pigmentation on the face, ears, feet and tail instead of the normal black coloration in these areas.

A. What would be the genotype of such a male cat? Indicate indifferent alleles by a question mark (?).

A locus	B locus	C locus	D locus	I locus	L locus	O locus	S locus
??	B?		D?	ii			
		$c^h c$ or $c^h c^h$			**ll**	**$X^O Y$**	**ss**

B. Would it be possible to generate the desired male cat in a single generation, starting with any pair of the cats shown above?

Yes _____ (see below) No **X Only cat 3 has the c^h allele.**

If yes, what two cats should Phil cross? Show their genotypes and the gametes they would need to produce to generate the desired genotype (for C, L, O, and S loci) of the long-haired, male orange Siamese.

What are the chances of coming up with the desired kitten in this first generation?

C. If you answered no to part B, could Phil get a cat of the desired phenotype in the second generation?

Yes **X** No _____

If yes, which cats should Phil start with? Give cat numbers (1-5) and pertinent genotypes (for C. L. O. and S loci). There are several possibilities.

Male #3

$c^h c^h$ l l X^oY S s

Female #2

C C L L X^OX^O s s

What first generation kittens (male and female) will be used to get the second generation? Give pertinent genotypes of these kittens.

Male Kitten

C c^h L l X^OY s s

Female Kitten

C c^h L l X^OX^o s s

What are the gametes the first generation kittens would need to produce to create the long-haired, male orange Siamese in the second generation:

Sperm

c^h l Y s 1/8

Egg

c^h l X^O s 1/8

What are the chances of coming up with the desired kitten in this second generation?

1/8 x 1/8 = 1/64.