Classical Genetics: Section 1-Observe the pedigree chart below (see figure 1). Circles are female and squares are male. Shaded circles or squares means the individual has a particular trait and an open circle or square means that the individual does not have that trait. The individuals are numbered to facilitate referencing them in your response to the questions below.

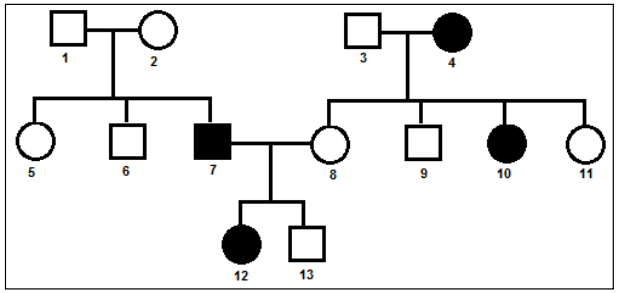

Figure 1

Q1. Based on this pedigree chart, is it possible that the trait is caused by a sex-linked recessive allele? Explain.

Q2. Give as much of the genotype as possible for the 13 individuals listed. D=dominant allele. d=recessive allele.

1	2	3	4	5	6	7	8	9	10	11	12	13

Classical Genetics: Section 2-In Drosophila (fruit flies), Gray body (G) is dominant over black body (g); Normal wings (V) is dominant over vestigial wings (v) and large bristles (B) is dominant over small bristles (b). This information is summarized in table 1 below:

Trait	Dominant Allele	Symbol	Recessive Allele	Symbol
Body Color (BC)	Gray	G	Black	g
Wing Size (WS)	Normal	V	Vestigial	v
Bristle Size (BS)	Large	B	Small	b

Table 1

Here are results from two crosses:

GgVv X GgVv	GgBb X GgBb
597 Gray (BC) Normal (WS)	903 Gray (BC) Large (BS)
204 Black (BC) Vestigial (WS)	308 Gray (BC) Small (BS)
43 Gray (BC) Vestigial (WS)	294 Black (BC) Large (BS)
39 Black (BC) Normal (WS)	98 Black (BC) Small (BS)

Q1. Based on the data above, what can you conclude about the position of the 3 alleles on the Drosophila Flies' chromosomes? Explain.

Q2. Which of Mendel's laws is exemplified by the data obtained in the 2nd cross? Explain.

Q3. What chromosomal phenomena resulted in the 43 Gray (BC) Vestigial (WS) and 39 Black (BC) Normal (WS) offspring? Explain.

Q4) What is the map distance between the genes (in map units) controlling body color and wing size? Show your work.

Classical Genetics: Section 3- In a plant called "blue eyed Mary (*C. parviflora*) there is a two step process used to make a blue colored pigment in the flower. Each step is dependent on an enzyme. Gene A codes for the enzyme needed in the first step and Gene B codes for the enzyme needed in the second step. The genes are not linked. The reaction is summarized in Figure 1.

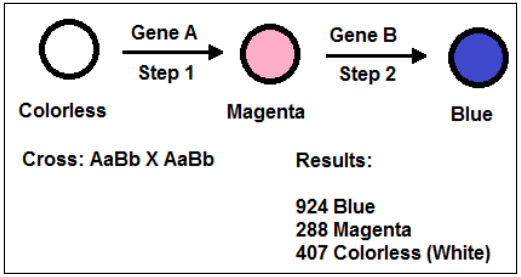

Figure 1

Q1. What is the phenotypic ratio expected in the cross: AaBb X AaBb?

Show Work Here

Q2. Do the actual results shown in figure 1 support the null hypothesis? Explain. Use the Chi Square table provided by your teacher. Show all work below.

Offspring	Expected (e)	Observed (o)	(o-e)	$(o-e)^2$	$(o-e)^2/e$
Blue		924			
Magenta		288			
Colorless		407			
				X^2=sum	

Q3. If the offspring are colorless (white), can you tell whether the plant makes the enzyme necessary for step two of the chemical reaction? Explain. (Bonus: What type of inheritance is involved in this cross?)

Classical Genetics: Section 4-In a slightly different twist from the last problem involving corn, the production of the purple pigment anthocyanin requires a two step process dependent on enzymes coded by unlinked genes A and B respectively (see Figure 1).

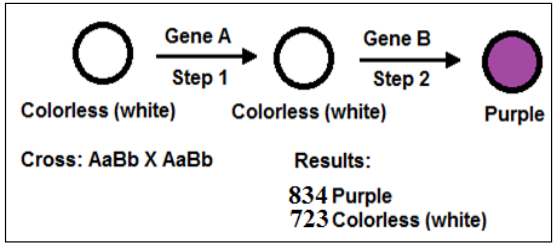

Figure 1

Q1. What is the phenotypic ratio expected in this cross?

_____

Show Work Here

Q2. Do the actual results (see figure 1) support the null hypotheis? Explain. Use the Chi Square table provided by your teacher. Show all work below.

Offspring	Expected (e)	Observed (o)	(o-e)	$(o-e)^2$	$(o-e)^2/e$
Purple		834			
White		723			
				X^2=sum	

Q3. (Bonus: What type of inheritance is involved in this cross?). Explain.

Classical Genetics: Section 5-The following questions relate to diseases which are caused by a sex-linked recessive allele.

Q1. A woman who is normal has a brother who dies from Duchenne's Muscular Dystrophy. Her parents are both normal. What are the chances that she is a carrier of the disease?

_____

Show Work Here

Q2. Hemophelia is also caused by a sex-linked recessive allele. A girl's mother is normal, but she has a brother and father with the disease, but she is normal. What are the chances that she is a carrier of the disease? What are the chances that her mother is a carrier?

_____

Show Work Here

Q3. The girl's mother and father are expecting another child. What are the chances that the child will have the disease?

_____

Show Work Here

Classical Genetics: Section 6-Tay-Sachs disease is caused by an autosomal recessive allele. The disease is due to a mutation in the HEXA gene on chromosome 15 such that the individuals with the disease are unable to make hexaminidase A. This results in the buildup of fatty substances called gangliosides which eventually causes the premature death of brain cells. Most children with the disease die by the time they are 4 years old.

Q1. A couple is expecting a baby. Both members of the couple each lost a sibling to this disease. What are the chances that the baby will have the disease? Explain.

Q2. A test has been developed to identify carriers of Tay-Sachs by measuring the activity of hexaminidase. Carriers of the Tay-Sachs allele make lower amounts of the enzyme than noncarriers, but that is sufficient to break down the gangliosides and so carriers show no symptoms of the disease. Based on that description, should Tay-Sachs inheritance be considered to exemplify intermediate inheritance or normal dominance? Justify your response.

Classical Genetics: Section 7-The gene for normal hemoglobin (Hb^A) is codominant with the gene for sickle cell hemoglobin (Hb^S). Table 1 to the right summarizes the effects of the three possible genotypes.

Genotype	Phenotype
$Hb^A\ Hb^A$	Normal Erythrocytes
$Hb^A\ Hb^S$	No Anemia, Erthrocytes Sickle when Oxygen Concentrations are Low
$Hb^S\ Hb^S$	Severe Anemia Sickling of the Erythrocytes

Table 1

Q1. How is the heterozygous condition of Tay-Sachs disease (see previous section) different from the heterozygous condition involving sickle cell hemoglobin?

Q2. What advantage do heterozygotes for sickle cell hemoglobin have in certain parts of the world?

Q3. What are the chances of having a child with sickle cell anemia if both parents are heterozygous for the trait? (Draw and fill in a punnet square to show your work.)

Answer_____

Q4. Justify the following statement: The use of the terms dominance, codominance and intermediate inheritance are *arbitrary*. Use the examples of Tay-Sachs and Sickle Cell Anemia to support the claim.

Classical Genetics: Section 8- ABO Blood type exemplifies an inheritance pattern in which there are three alleles in the population; I^A, I^B and i. I^A and I^B are codominant and i is recessive. This genetic pattern known as multiple alleles increases the number of phenotypes that are possible. In this case, there are four possible phenotypes (specifically blood types); A, B, AB and O.

Q1. What are the possible phenotypes (blood type) from each of the following crosses? Explain below.

Cross	Mother	Father	Possibe Blood Type s) of Child
1	A	A	
2	A	B	
3	A	AB	
4	A	O	
5	AB	AB	
6	AB	O	
7	O	O	

Cross 1_____

Cross 2_____

Cross 3_____

Cross 4_____

Cross 5_____

Cross 6_____

Cross 7_____

Classical Genetics: Section 9-Imaginary genes R, B and D are linked on the same "arm" of the same chromosome.

R=round head is dominant over r=square head
B=brown belly is dominant over b=white belly
D=dark eyes is dominant over d=light eyes

The following cross is made: RrBbDd X rrbbdd. For the triple heterozygote parent the three dominant alleles are on the same chromosome. However, the order of the three alleles is not known.

The cross, repeated many times results in the following offspring:

373 round head, brown belly, dark eyes
361 square head, white belly light eyes
89 square head, brown belly, light eyes
94 round head, white belly, dark eyes
28 square head, brown belly, dark eyes
35 round head, white belly, light eyes
9 round head, brown belly, light eyes
11 square head, white belly, dark eyes

Q1. What is the order of the genes on the chromosome, RBD or RDB or BRD. What are the map distances between the alleles?

Order of Alleles _____

Map distance: Between B and D _____
Between R and D _____
Between R and B _____

Q2. Which of the following offspring were NOT the product of a crossover event? _____
Single crossover event? _____
Double crossover event? _____

Q3. In the space below, draw the crossover event(s) that leads to offspring that WERE the product of at least one chromosomal crossover.

Classical Genetics: Section 10-If one wants to study patrilineal (male) descent, then Y-chromosome sequencing is the most informative approach. On the other hand, if one wants to study matrilineal (female) descent, then mitochondrial DNA sequencing is most informative.

Q1. Explain why sequencing mitochondrial DNA is most useful when looking for the most recent woman from whom all humans evolved.

Q2. Till recently, there was a disparity in the calculation of when our last common maternal and paternal ancestor existed. In fact the date of our last common maternal ancestor was believed to be up to three times older than our last common paternal ancestor. A study of the Y-chromosome[1] seems to have eliminated that disparity. Explain why sequencing the Y-chromosome is most useful when looking for the most recent man from whom all humans evolved.

Endnotes

1. Cann, R. "Y Weigh In Again on Modern Humans". Science. 2013; 341:465-467. August 2, 2013.