CLASSICAL GENETICS ANSWERS

Identify *Mendel's two principals and provide a* ***description*** *of each. Which principal can be applied to describe genetic variability?*

Mendel's 2 Laws	**Law of Segregation, Law of Independent Assortment**
Description	**Segregation – splitting of gametes so only 1 is passed on by parent**
	Assortment – genes are individual of each other and don't morph together

Match *the terms on the left with the correct description on the right.*

Term		Description	
F	Genotype	A.	an alternate form of a gene
A	Allele	B.	plants first studied for inheritance of characteristics
I	Monohybrid	C.	how gene pairs are assorted
D	Homozygous	D.	when both alleles are the same
J	Mendel	E.	the gene that is expressed only when homozygous
B	Peas	F.	the genes present in an organisms cells
H	Phenotype	G.	stamen & pistel are on different flowers
C	Independently	H.	the appearance of an organism
G	Cross Pollination	I.	a cross involving only one pair of traits
L	Dominant	J.	discovered the principles of heredity
E	Recessive	K.	the stamen & pistel are on the same flower
K	Self Fertilization	L.	the gene that masks the effects of other genes

True or False?

Two alleles of Gg are G and g	**True**
Yy is a heterozygous genotype	**True**
rr is homozygous dominant	**False – homozygous recessive**
Gametes contain 2 alleles of each gene	**False – 1 allele per gamete**
The phenotype Tt is heterozygous	**True**
UU is a homozygous dominant genotype	**True**
The genes T and t both code for the same trait of the individual	**True**
The phenotype is the appearance of the individual	**True**
Dominant genes are only expressed when in a homozygous individual	**False – also heterozygous**
r is dominant over R	**False – r is recessive**

Invent *appropriate allele symbols for the following pairs of dominant and recessive traits. Assume the trait listed first is the dominant trait.*

Trait Colors	Allele
yellow and white flowers	**Y – yellow, y - white**
brown and silver fur	**B – Brown, b - silver**
spotted and solid coat	**S – spotted, s - solid**
brown and blue eyes	**B – brown, b - blue**

Classify *the following traits as examples of a genotype, phenotype or both?*

Trait	Classification
curly hair	**Phenotype**
Rr	**Genotype**
A person with blue eyes	**Phenotype**
A person with an allele for blue eyes and one for brown	**Genotype**
A person who is homozygous for green eyes	**Genotype**

State *the genotypes of the following traits.*

Trait	Genotype
Homozygous green pod pea plant (green is dominant)	**GG (G – Green)**
Homozygous short-haired hamster (short is recessive)	**TT (T – tall)**
Homozygous six-fingered man (5 fingers is dominant)	**ff (F – 5 Fingers)**
Heterozygous striped tiger (no stripes is recessive)	**Ss**
Homozygous sickle blood cells (normal cells are dominant)	**nn (N – normal)**

Define the term test cross. Describe the conditions when a test cross may be beneficial.

Definition **A cross between a dominant BUT UNKNOWN genotype and a recessive trait**

Description **Often used by breeders to ensure that they are breeding pure bred animals and Reduce the likelihood of hybrids or recessive offspring**

CROSSES A

1. In summer squash, white fruit color is dominant over yellow.
   a) If a squash plant homozygous for white is crossed with one homozygous for yellow, what will be the genotypes and phenotypes of the F1 offspring?

WW x ww = (F1) 100% Ww 100% white

   b) Use a punnett square to diagram a cross between two F1 individuals. What are the genotypic and phenotypic ratios for the offspring?

(F1) Ww x Ww = (F2) 1 WW: 2 Ww: 1 ww 3 White: 1 Yellow

2. What are the possible genotypes and phenotypes if we cross 2 heterozygous tall pea plants?

Tt x Tt = (F1) 1 TT: 2 Tt: 1 tt 3 Tall: 1 Short

3. If two pea plants are crossed and the F1 offspring includes one homozygous tall pea plant, what are the phenotypes and genotypes of the parents?

Given (F1) 1 TT = both parents must have been tall

4. The following problems are based on Wyandotte poultry in which rose comb is dependent upon a dominant gene, and single comb upon its recessive allele. To be included in the Wyandotte flock, a bird must have a rose comb.
   a) What would be the genotypic and phenotypic ratios for F1 offspring of a cross between the two heterozygous birds?

Rr x Rr = (F1) 1 RR: 2 Rr: 1 rr 3 Rose: 1 Single

   b) A rose-combed male is mated with two rose-combed females. Female A produces 14 chicks, all of which are rose-combed. Female B produces 9 chicks, seven of which are rose-combed and two which are single-combed. What are the genotypes of the three parent birds?

R_ x R _ = (F1) Rose (R_)	R_ x R _ = (F1) 7 Rose (R_), 2 Single (rr)
Male and Female B must be Rr to produce rr offspring, Female A could be either RR or Rr based on info	

5. Albinism is a failure to produce the enzyme needed to make melanin. It is recessive to normal pigmentation. An albino woman whose father is albino and mother normal, marries a normal man, one of whose parents is normal and the other albino. He has an albino sister. The couple have a normal daughter. Identify all genotypes and phenotypes.

nn (father) N_ (mother) N_ (parent 1) nn (parent 2) nn (woman) **X** N_ (man) nn (sister) (F1) N_ Mother – Nn (bc of albino woman), Parent 1 – Nn (bc of albino sister), F1 – Nn (because of mother)

6. What is the probability of a heterozygous dominant parent and a recessive parent having an affected boy if a particular trait is autosomal recessive?

Nn x nn = (F1) 2 Nn: 2 nn 2 Normal: 2 Affected Probabilty = ½ being affected x ½ being a boy = ¼ probability

7. CROSSES B

1. In snap dragons, yellow flower color is not completely dominant over white. The heterozygous condition produces pale-yellow flowers.
   a) What will be the result of a cross between two pale-yellow flowered plants?
   (P) C^wC^y x C^wC^y = (F1) 1 C^wC^w: 2 C^wC^y: 1 C^yC^y 1 White : 2 Pale : 1 Yellow
   b) What will be the result of a cross between a pale-yellow flower and a white flowered plant?
   (P) C^wC^y x C^wC^w = (F1) 1 C^wC^y: 1 C^wC^w 1 Pale: 1 White

2. Yellow coat color in guinea pigs is produced by the homozygous genotype C^yC^y, cream color by the heterozygous genotype C^wC^y, and white by the homozygous genotype C^wC^w.
   a) What genotypic ratio are matings between cream-colored individuals likely to produce?
   (P) C^wC^y x C^wC^y = (F1) 1 C^wC^w: 2 C^wC^y: 1 C^yC^y
   b) What phenotypic ratio are matings between cream-colored individuals likely to produce?
   (P) C^wC^y x C^wC^y = (F1) 1 White : 2 Cream : 1 Yellow

3. In the four o'clock, a flower rather like a petunia, the allele for red flower color is incompletely dominant over the allele for white flower color. When a red flower is crossed with a white one, an intermediate pink flower is produced.
   a) Show the genotypes of the parents and the F1 generation of a cross between a red and a white four o'clock flower.
   (P) C^rC^r x C^wC^w = (F1) 4 C^rC^w
   b) What would be the anticipated offspring if the F1 plant from above were crossed back with the red parent? ……. With the white parent?
   C^rC^w x C^rC^r = (F1) 1 C^rC^w: 1 C^rC^r 1 pink : 1 red

4. Lethal alleles have such a detrimental effect on an organism that the organism cannot survive. Some lethal dominant alleles exhibit incomplete dominance, in which only the homozygous individual succumbs to the allele and dies. An example is the creeper chicken who has a heterozygous (Cc) who is damaged, a normal chicken is (cc), and death occurs in genotype (CC).
   a) A creeper chicken (Cc), heterozygous for a lethal allele, mated with a normal chicken (cc). What is the expected genotypic ratio of the F1 generation?
   (P) Cc x cc = (F1) 1 Cc : 1 cc
   b) Why didn't the lethal allele (C) cause death in any of the embryos of this cross?
   Because the normal parent must give a “c” so can’t be lethal “CC”

5. A mating of an albino (white) guinea pig and a black one gave 3 white, 3 black, and 6 brown offspring in the F2 generation.
   a) What were the genotypes for the albino (Cw) and the black (Cb) parent guinea pigs respectively?
   If F2 is a 1:2:1 ration, the F1 must be heterozygous, parents must be homozygous
   b) What kinds of offspring, and in what proportions, would result from the mating of the black parent above with another animal of the same genotype?
   If black is crossed with same parent (ie. Black) then expect all black offspring

CROSSES C

1. I^A and I^B are considered to be co dominant while I^O is recessive to both I^A and I^B. Develop a key to show all possible genotypes?

   Type A – I^AI^A or I^Ai^o, Type B – I^BI^B or I^Bi^o, Type AB – I^AI^B , Type o– i^oi^o

2. A parent has type O blood. Which blood type could not be found in any of the children in this family? Explain

   Cannot find AB – other are possible since A and B can form in a heterozygous form

3. The children of a man with type A blood and a woman with type B blood were tested for blood type. Of the four children, one had type A, one had type B, and one had type O blood. What were the genotypes of the parents?

   If F1 are A, B and O – parents must both be heterozygous to produce O

4. Two babies get mixed up in a hospital. Baby 1 has type AB blood and baby 2 has type A blood. Mr. Jones has type A blood and Mrs. Jones has type O blood. Mr. Smith has type AB blood and Mrs. Smith has type B blood. Which baby belongs to the Jones and which baby belongs to the Smiths?

   Mrs Jones is type O – she cannot have an AB Baby so Baby 2 is theirs

5. Multiple Alleles control the intensity of pigment in mice. The gene D1 designates full color, D2 designates dilute color and D3 is deadly when homozygous. The order of dominance is D1>D2>D3. When a full-color male is mated to a dilute color female, the offspring are produced in the following ratio: two full color to one dilute to one dead. What are the genotypes of the parents?

   Parents are D1 __ x D2 __ and produce a D3D3 offspring, they must be heterozygous

6. Plumage color in mallard ducks is dependent upon a set of three alleles: M^R for restricted mallard pattern, M for mallard, and m for dusky mallard. The dominance hierarchy is M^R>M>m.
   a) What genotypic ratio is expected in the F1 generation when crossing M^RM^R with M^RM?

      (P) M^RM^R x M^RM = (F1) 1 M^RM^R : 1 M^RM

   b) What phenotypic ratio is expected in the F1 generation when crossing M^RM^R with M^RM?

      (P) M^RM^R x M^RM = (F1) All Restricted

   c) What percentage of the F1 generation are expected to be restricted mallard pattern when crossing M^RM with M^Rm?

      (P) M^RM x M^Rm = (F1) 1 M^RM^R : 1 M^RM : 1 M^Rm : 1 Mm 50% Restricted

CROSSES D

1. Short hair (L) is dominant over long hair (l) in rabbits. In addition, the gene for spotted coat color (S) is dominant over the allele for solid color (s). two dihybrid rabbits (heterozygous for both alleles) are mated. What phenotypes are expected, and in what ratios, among the bunnies produced?

(P) LlSs x LlSs	=	(F1)	9 Short/Spotted : 3 Short/Solid : 3 Long/Spotted : 1 Long/Solid

2. In watermelons, the genes for green color and for short shape are dominant over their alleles for striped color and for long shape. Suppose a plant with long striped fruit is crossed with a plant that is heterozygous for green color and homozygous for short shape. What are the phenotypes and their respective ratios?

(P) ggss x GgSs	=	(F1)	1 Green/Short : 1 Green/Long : 1 Striped/Short : 1 Striped/Long

3. Some dogs bark while others are silent when trailing. The barking characteristics (B) is dominant. Erect ears (E) are dominant to drooping ears. List the genotypes, genotypic ratio, phenotypes and phenotypic ratio expected in pups when a heterozygous erect-eared barker crosses with a droopy-eared, silent-trailer.

(P) EeBb x eebb	=	(F1)	1 EeBb (erect/barker) : 1 Eebb(erect/silent) : 1 eeBb (droopy/barker) : 1 eebb (droopy/silent

4. If one individual is homozygous for two dominant traits and another is homozygous for two recessive traits, and if the two individuals are crossed, what proportion of the F1 offspring from this cross will resemble each parent in appearance? The F2 offspring?

(P) AABB x aabb	=	(F1)	All AaBb – dominant for both traits
(F1) AaBb x AaBb	=	(F2)	9 Dom A/Dom B : 3 Dom A/Rec B : 3 Rec A/Dom B : 1 Rec A/Rec B

5. In the garden pea plant, round seed shape (R) is dominant over wrinkled (r), and yellow seed color (Y) is dominant over green (y).
   a) What phenotypes would be expected, and in what ratios, in the F2 from the cross of a homozygous wrinkled, yellow plant to a round, green one?

(P) rrYY x RRyy	=	(F1)	All RrYy – Round/Yellos
(F1) RrYy x RrYy	=	(F2)	9 Round/Yellow : 3 Round/Green : 3 Wrinkled/Yellow : 1 Wrinkled/Green

   b) In the F2, what is the ratio of round to wrinkled? What is the ratio of yellow to green?

3 Round : 1 Wrinkled (reduced from 12 : 4), 3 Yellow : 1 Green (reduced from 12 : 4)

CROSSES E

1. Human color blindness is a sex-linked trait due to a recessive gene.
   a) If a woman with normal vision (but a carrier) whose husband is color blind have children what percentage of the **boys would be color blind**?

(P) X^NX^n x X^nY = (F1) 50% of the boys X^nY

   b) What is the probability that a woman with normal color vision whose father was color blind, and whose husband has normal vision will have a **color blind child**?

(P) X^NX^n x X^NY = (F1) 25% chance of a CB child (X^nY)

2. An X-linked gene (c) produces red-green color blindness. A normal woman whose father was color blind marries a color blind man.
   a) What are the chances that the **first child will be a boy** who is **color blind**?

(P) X^NX^n x X^nY = (F1) ½ being a boy x ½ that boy will be CB = ¼ chance

   b) Of all the phenotypes produced from this marriage, what **percent of the girls** are expected to be color blind?

(P) X^NX^n x X^nY = (F1) 50% of the girls X^nX^n

   c) Of all the children, sex unspecified, from this marriage, what proportion are expected to be normal?

(P) X^NX^n x X^nY = (F1) 50% of the offspring X^nY, XnX^n

3. In cats which are XX (female) and XY (male), the X-linked allele (B) determines black coat color when homozygous, yellow when homozygous recessive (b), and tortoise shell (calico), a mixture of black and yellow, when heterozygous. The Y chromosome lacks the gene for hair color.
   a) A yellow mother has a litter consisting of two yellows and three calico offpsring. What is the genotype of the father?

Mother is X^bX^b – F1 has 2 yellow and 1 calico – Father must be X^BY

   b) A calico mother has a litter of six: one yellow male, two black males, one yellow female and two calico females. What is the genotype of the father?

Mother is X^BX^b – F1 a yellow female – Father must be X^bY

   c) A calico mother has a litter of three black females. If the father was black, how often would you expect the same results to happen?

Mother is X^BX^b father is X^BY – F1 3 black females – 50% of the time bc F1 could be X^BX^B or X^BX^b for females

4. In cats the genotype BB is black. Bb is tortoise shell and bb is yellow. The gene is on the X chromosome. A tortoise shell female is crossed with a black male.
   a) What offspring would be expected?

(P) X^BX^b x X^BY = (F1) 1 X^BX^B : 1 X^BX^b : 1 X^BY : X^bY

   b) Would you expect to find any tortoise shell males?

No because they only have a single X chromosome

5. In men color blindness is due to a sex-linked recessive allele while blue eyes are due to an autosomal recessive allele. Two brown-eyed persons with normal vision produced a blue-eyed color blind son. What are the genotypes of the parents?

Some unknowns exist here – Parents are known to be - B_ X^NX- B_X^BY and they produce bbX^nY, based on the offspring being blue eyed, both parents must be Bb x Bb, being CB means mom was X^NX^n since mom passes on the X^n and dad is passing on the Y

CHROMOSOME MAPPING

1. Map the chromosome based on the information below (crossover frequency).

R - T = 16%
O - T = 32%
R - Z = 19%
O - R = 16%
Z - O = 3%

Sequence – Z, O, R, T or T, R, O, Z

2. Map the chromosome based on the information below (crossover frequency).

Gene Marker to Purple Eyes	4%	Straight Wings to White Eyes	18%
White Eyes to Purple Eyes	12%	Gene Marker to White Eyes	16%
Straight Wings to Purple Eyes	6%		

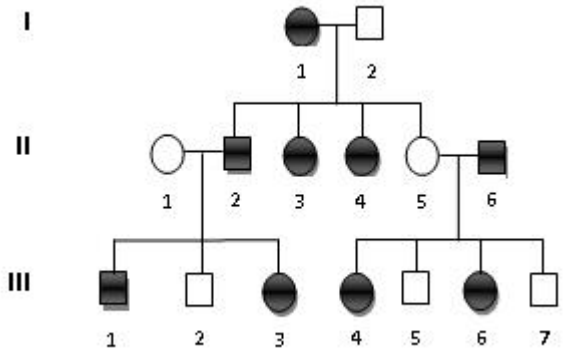
Straight – Gene Marker – Purple – White
Or
White – Purple – Gene Marker - Straight

3. The data below show the rates at which crossovers occur for certain genes in Drosophila. Use this information to determine a gene order for the chromosome on which these genes are located.

Curved wings/vestigial wings	8.5	lobe eyes/reduced bristles	21
Curved wings/reduced bristles	24.5	vestigial wings/purple eyes	12.5
Reduced bristles/purple eyes	3.5	vestigial wings/black body	18.5
Black body/lobe eyes	23.5	purple eyes/curved wings	21

Curved Wings – Lobe Eyes – Vestigial Wings – Purple Eyes – Reducued Bristles – Black Body
Or\
Black Body – Reduced Bristles – Purple Eyes – Vestigial Wings – Lobe Eyes – Curved Wings

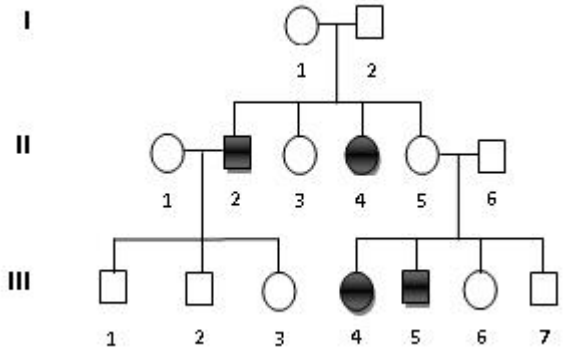
PEDIGREES Classify *the pedigrees as being recessive/dominant and autosomal/X-Linked.* ***Develop*** *a key to represent the possible genotypes on the pedigree.*



Classification Dom, X-Linked

Key

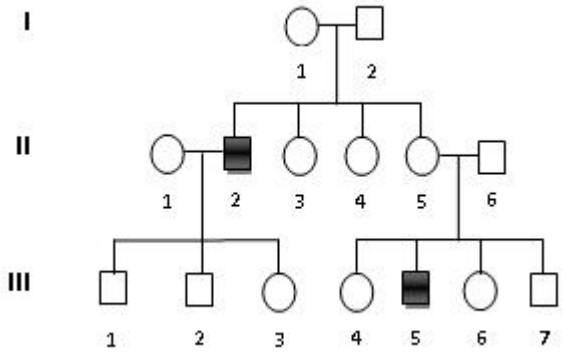
X^NX^N – Affected female
X^NX^n – Affected female
X^nX^n- Unaffected female
X^NY – Affected male
X^nY – Unaffected male



Classification Rec, Autosomal

Key

AA – Unaffected male or female
Aa - Unaffected male or female
Aa - Affected male or female



Classification Rec, X Linked

Key

X^NX^N – Unaffected female
X^NX^n – Unaffected female
X^nX^n- Affected female
X^NY – Unaffected male
X^nY – Affected male

Look at the following pedigree for the trait that has the dominant allele "A" and recessive allele "a". State the genotypes of the individuals and state whether this trait is dominant-recessive (autosomal inheritance) or sex-linked inheritance. – **Recessive, X-Linked**